AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

PUBLISHED MONTHLY AT NO. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, . . . Editor and Proprietor.
FRANK J. FRENCH, . . . Business Manager.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single Copies..... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

The paper may be obtained and subscriptions for it sent to the following agencies:
Chicago, News Stand, Grand Pacific Hotel.
London, England, Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.
Berlin, Germany, W. H. Kühl, 73 Jäger St.

NEW YORK, JULY, 1894.

EDITORIAL NOTE.

As we go to press a report is at hand regarding some remarkable results that have been obtained at the Indian Head Proving Grounds with the Carpenter shells. It seems that a 13 in. projectile, weighing 1,100 lbs., has been fired through a 17-in. nickel steel plate with its customary backing, and after plowing through the sand butts against which the plate was placed, was finally recovered unbroken and to all intents as good as new in the woods, 500 yards away. This remarkable performance shows what a tremendous engine of destruction the Government has secured in the new 13-in. gun that has been nick named the *Peacemaker*. The result of these tests leads one to believe that it could drive a missile through the armor plating of the heaviest battle ship afloat.

THE CONVENTIONS OF THE MASTER CAR-BUILDERS' AND MASTER MECHANICS' ASSOCIATIONS.

AFTER writing an annual editorial on these meetings for more than twenty years, a writer does not find it easy to say anything new or original about them. After an existence of more than a quarter of a century, these associations conduct their proceedings very much in the same way now as they did at first. There has been, of course, much change in the *personnel* of the attendance. Year by year the old members have been thinned out, and when we review the ranks there are many vacancies, but still more new recruits. A person on the descending side of life's journey, with one foot in the fifties and the other uplifted to be planted next in the sixties, who a quarter of a century ago was very much the junior of those who organized and carried on the business of the associations, now finds himself in the shade among the seniors, the great bulk of the membership being on the sunny side of fifty.

But while there is no radical change there has been much improvement in the methods of conducting the business of these organizations. The influence of the graduates of the technical schools is shown more and more each year. The reports are prepared more systematically, which is the result of the knowledge and training which scientific education gives. In some ways, though, the influence of the more liberally educated members has not been without some drawbacks. The older, and many of the younger men who have risen from the ranks now often hesitate to take part in the discussions. One of the profitable features of these meetings was that the men who acquired their knowledge directly from practical experience gave the results of their observations in the clear and concise way that is characteristic of their class. Book knowledge can never entirely displace this kind of information. In fact, knowledge, like matter, may be divided into three kinds—solid, liquid and gaseous. The practical men generally contribute the solid variety. The liquid information comes from those whose principal stock has been obtained from books, and the gaseous from the chronic windbags. When a graduate first leaves a technical school his contributions to the subjects about which he has been instructed is very apt to be of the liquid variety, and it is only after considerable experience that the fluid becomes solidified. Generally a chemical change is required before the contents of a gas-bag can be consolidated.

Probably very few of the people who attend these meetings and who have a real interest in their proceedings ever leave them without feeling that they have failed to accomplish what might reasonably be expected of them, and that reform and improvement ought not to be difficult. All who have undertaken to make any great changes have, however, been vanquished in the effort, and, as has been said, the meetings are conducted now in very much the same way as they were twenty-five years ago. The attendance is larger, it is true, and the general conduct of those who are present is more decorous than it was in the early days, but otherwise a report of the proceedings of one of the meetings held in the seventies is very much like one held in the nineties. There are, though, some things which it would seem possible to improve, and which, if they were so changed, would add immensely to the interest and value of the proceedings. We will venture to suggest a few of these.

It has been said of the British Parliament, and is equally true of all other legislative bodies, that it is essentially a deliberative or a *talking* body. The purpose of such assemblages is chiefly to deliberate—that is, to consider various subjects—and by having every important fact, relation, aspect and argument concerning such subjects presented, to enable those who are deliberating to form the most intelligent opinions and come to the wisest conclusions. Deliberation means talk. Everything should therefore be done to facilitate it and to make it effective. It is, of course, true that wise and intelligent discussion is edifying, while foolish and ignorant vaporing is unprofitable; and the aim of deliberation should be to elicit wisdom and knowledge, but these will only be revealed by discussion. The object of both of the associations, as expressed by their constitutions, is "the advancement of knowledge . . . by *discussions* in common." Notwithstanding this fact, it is curious to notice that many of the members seem to feel that discussion is a waste of time and merely a kind of safety-valve for letting off the steam of the more loquacious members. Over and over again it has happened during the last and other conventions that just when a discussion had reached a point where it began to be interesting, and when it was quite certain to lead to the elucidation of valuable information, some member would move "that the discussion be now closed," and the vote would be taken thereon, and nine times out of ten the gag rule would

be adopted, and, no matter how much members desired to speak, the debate was ended. George Eliot has said that "comprehensive talkers are apt to be tiresome when we are not athirst for information." Now, it happens that there is hardly a subject which can be brought up for discussion, no matter what its importance may be, that will interest the whole audience. There will always be some who will not "be athirst for information;" and, under the existing rules and practices, it is nearly always possible for such people to end the discussion of a subject, no matter how much others may want to get and to give information about it. Some amendment to the rules of procedure, or the practice of conducting debates, seems to be needed. In order that members may vote intelligently on a motion to close a debate, it should be known to the Association whether any of them, and which ones, wish to speak on the question before the house. If, when a motion is made to close debate, the question, "Are there any other members who desire to speak?" was asked before a vote is taken thereon, then, if any persons whose general intelligence and knowledge of the subject would entitle them to be heard should indicate a desire to speak, it might incline others to give them an opportunity to do so. If, on the other hand, some of the tiresome and fatuous variety of talkers should want to express their views, it probably would induce members to vote to have the debate ended. If a rule were adopted that before a motion to close debate be put, the chairman should first ask whether any other members desire to be heard, and that an opportunity should be allowed those who wish to speak to say so, and that a vote be then taken on the motion, it would give the members an opportunity of knowing whether any persons who are worth listening to had anything to say before the debate is finished.

Another interference with discussion at the last meeting—and a similar cause of disturbance has existed at nearly all previous meetings—was the bad acoustic character of the room in which the meetings were held. A very large proportion of the audience could not hear half of the proceedings. Members grew tired, lost interest in the proceedings, and either left the room or moved "that the discussion be closed," and thus ended as soon as they could the dumb show. The meeting was often disturbed by the people who had exhibits, which were being either packed or unpacked during the sessions of the conventions. The noisy band which played every morning was placed so near to the meeting-room that it also interfered seriously with the proceedings. Probably the total expense of holding each of the conventions was over $100,000, and yet their main purpose was largely defeated by the fact that the room in which they were held was not suited for such meetings. The Saratoga people have built a large convention hall which will hold several thousand people, but for that reason it is not suited for meetings of two or three hundred. What is needed, then, is a small room capable of seating about three hundred people, located where there would be no danger of disturbance by noise, and arranged with special reference to meetings of technical and scientific associations. If placed in the middle of Congress Spring Park, it would be in an ideal location. Such a hall would make Saratoga a much more desirable place for holding meetings of this kind than it now is, and doubtless would do much to attract associations of that kind to its hospitable hotels and aperient springs.

Another reform in the Master Mechanics' Association which is very much needed is to make the Secretary an appointee by the Board of Direction instead of an elective officer. On the last day of the session of that body there was an unseemly scramble for the place, in which the methods of the ward politicians were imitated too closely to increase the good repute of the Association. The following is the clause of the Master Car Builders' constitution for the appointment of the Secretary:

"A Secretary, who may or may not be a member of the Association, shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment of the Executive Committee, organized for the transaction of business. Two thirds of the members of the Executive Committee shall, however, have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office, by a vote of a majority of the Executive Committee. He shall also act as Secretary of the Executive Committee."

It seems obvious, without any argument, that those who are on the Executive Committee of an association of this kind will be better judges of the qualifications and efficiency of a secretary than the members generally can or will be. A better secretary is therefore likely to be selected if he is appointed in this way than if he is elected. Ever since this clause was adopted by the Car Builders' Association there have been no such scandals as those to which the American Society of Civil Engineers and the Master Mechanics' Association are subject periodically. In the American Society of Mechanical Engineers the Secretary is also appointed, and there has been no trouble there and the Association has been served acceptably.

There is also another reason for making the Secretary an appointee of the Board of Direction and not an elective officer, which is, that the self-respect of a person entirely competent for the office is likely to prevent him from entering into an indecorous contest for the place, whereas if it were offered him by the Board it would be regarded as an honor and could be accepted without loss of dignity.

There was again considerable discussion this year of the question of the consolidation of the two associations, and it was recommended in the address of the President of the Master Mechanics' Association, but was again strongly opposed by many of the car builders. Inasmuch as all the advantages of consolidation could be gained without it, it would seem to be wise to avoid exciting the opposition which that measure always arouses. This year the Master Mechanics held their first meeting on Monday morning, and the attendance was very good. It used to be thought that it would not be possible to get the members to the place of meeting on Monday, but it has been shown that there is no difficulty of that kind. If, then, the Car Builders should meet on Monday morning, they could have Monday, Tuesday and Wednesday. The Master Mechanics could then have Thursday, Friday and Saturday. It would make little practical difference whether different sets of officers presided over the meetings of the two associations, or whether the same presided over both. The important end would be accomplished of holding the two meetings in one week, the actual consolidation being largely a formality only.

The place of holding the next conventions excited the usual interest. The Far West is holding out inducements to go to Manitou, the attractions of which are painted in glowing colors. The Rocky Mountains, soda springs and grizzly bears are mixed up in enticing confusion, so that probably in 1895 these associations will meet nearer to the setting sun than ever before.

NEW PUBLICATIONS.

MAXIMUM STRESSES IN DRAWBRIDGES HAVING TWO EQUAL ARMS. By Malverd A. Howe, C E., Professor of Civil Engineering in Rose Polytechnic Institute. Terre Haute: Moore & Langen, 1894. 12mo, paper, 17 pages, 15 cuts and one plate.

This little pamphlet gives the well-known formulas for reactions, moments and shears, due to a single load on either arm of a drawbridge, with several useful tables for abridging computations. The position of the rolling load which produces maximum stress for each section is stated, and methods of graphical analysis are briefly indicated. The things which are not given are numerous, and among these are: demonstra-

tions of the formulas, explanations of the theory of the methods, a numerical example of stresses, the case of the tipper draw, and that of a draw continuous over two supports at the middle pier. The formulas for the single case investigated are not complex, but they can be simplified and the tables also be abridged by measuring the ordinate in the right-hand span from the abutment instead of from the pier; if this be done the last table on page 17 is unnecessary, as all its values are identical, but in reverse order with those of the table on page 15. The rule of thumb method set forth in the pamphlet is often an excellent one, but it cannot be trusted in computing drawbridges, where, if anywhere in bridge work, theory is indispensable.

TRADE CATALOGUES.

CLAYTON AIR COMPRESSORS AND AIR RECEIVERS. The Clayton Air Compressor Works, whose office is in the Havemeyer Building, New York, have issued an eight-page, 8 × 11 in. circular, in which they illustrate and describe their air compressors of different types and air governors and receivers. As so many appliances in which compressed air is the operative power, this circular is timely and will interest many persons.

BEAMAN AND SMITH'S CATALOGUE B. 34 pp. 3½ × 5½ in. The specialty of this firm, which is located in Providence, R. I., is the manufacture of milling, drilling and boring machines and engine lathes. Seven milling machines are illustrated by very good engravings, but which have hardly had justice done to them in the printing. Six different styles of drilling and boring machines are also illustrated and several patterns of lathes. Short descriptions of the different machines are given opposite to the engravings. The machines seem to be well designed, and their merits are fully described in this catalogue.

THE NEW ERA GAS AND GASOLINE ENGINES. 8 pp. 6 × 3½ in. This is a little booklet in which the advantages of gas and gasoline engines are set forth. There are no engravings excepting an outside perspective view of one of the engines on the outside cover. It is a curious fact that although very few people understand the construction or operation of gas engines, the manufacturers seldom describe either in their circulars or catalogues. It would certainly add to their interest if good sectional views of the engines were given with a clear description of the principles and methods of their operation. The publication before us was issued by the New Era Iron Works, of Dayton, O.

THE MARSH STEAM PUMP. By the Battle Creek Machinery Company, Battle Creek, Mich. 32 pp. 5½ × 7½ in. One of the marked characteristics of trade catalogues which have been received recently is their lucidity. Manufacturers do not now confine the contents of their publications to commendation of the articles they manufacture, but they explain very fully their construction, operation and other characteristics. The volume before us is an illustration of this. The pump which they make is shown by very good perspective and its construction by sectional views with full explanations of its principal features. Diagrams are also given showing its application to the heating of buildings, to dryers in paper or pulp mills, to dry kilns, to refineries and plantation sugar houses, to vacuum and multiple effect evaporators and to the handling of fuel oil.

THE AERODROMIC SYSTEM OF TRANSPORTATION. In the May number of the AMERICAN ENGINEER AND RAILROAD JOURNAL a notice was published of a pamphlet describing this "system of transportation." The notice was written at a time when we were sorely irritated by a number of exasperating aeronautical cranks, and it ended with a somewhat caustic reference to inventors of schemes of the character of the one described in the pamphlet referred to. One of the authors of the system referred to has written complaining that our criticism was unfair and discourteous in so far as it was personal and referred to the inventors and not to the invention. There are good grounds for this complaint, and therefore we desire to express our regret at having hastily and in a moment of irritation written what we had no right to say, and criticised the personality of the inventors, which was not fairly a subject for such criticism. The inventors we think are wasting their time and their own money—or that of other parties—in developing a scheme which seems to us to be totally impracticable, and we will be quite willing to submit to the decision of the final result of experiment with their invention to determine whether our reasoning or theirs is "logical."

WESTON ENGINES. By the Weston Engine Company, Painted Post, N. Y. 35 pp. 6¼ × 9¼ in. This company has issued one of the most complete catalogues that has recently been brought to our notice, in which is the Weston automatic engine, which is built by this company. The engravings are by Bartlett, and are therefore in the very best style of the art of wood engraving. Two perspective views are given, one showing their engine with and the other without the sub-base. There is also an end view, and—what is unusual in such publications—a plan view with the cylinder shown in section. Longitudinal and transverse sections of the cylinder and steam-chest showing the construction of the valve, a perspective view of the latter, a section of the piston-rod stuffing-box, an elevation of the governor and a perspective view of the crank-shaft, cross-head, connecting-rod, a section of the stub end and a transverse sectional view drawn through the crank shaft. Accompanying these engravings are admirable descriptions of the engines and their parts, and the book winds up with an excellent explanation of that never-ending question how to calculate the H.P. of an engine. The book is a model of its kind, and if the engines the company builds are as good as their description of them they can be highly recommended.

SIMPLE AND COMPOUND HARRISBURG IDE AND IDEAL ENGINES. By the Harrisburg Foundry & Machine Works, Harrisburg, Pa. 16 pp. 3½ × 6 in. Having exhausted our superlatives in the preceding notice, we feel like saying *ditto* to the little book now before us. In this the engines built by this company are illustrated by half-tone engravings showing perspective views of the "Ide and Ideal automatic engines" and "Ideal tandem compound engine," and three views of "Ideal" engines connected direct to dynamos. There are also views of an "Ide" and a compound engine connected in the same way. The principal dimensions are given opposite these engravings, but there is no other description. The printing, engraving and general "get-up" of this book are all excellent.

CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

THE twenty-seventh annual convention of the American Railway Master Mechanics' Association held its first session in Convention Hall, at Saratoga, N. Y., on the morning of June 18. Conside able disappointment was manifested from the fact that Mr. Chauncey M. Depew had been announced to open the meeting, but a telegram was received late the evening before stating that he was confined to his house by a severe cold. The opening address was delivered by Judge Lester, of Saratoga, and was followed by President Hickey with the annual president's address.

Referring to prospective savings in the expense of locomotive operation and the methods of obtaining them, Mr. Hickey alluded to a compound locomotive that was engaged in ordinary freight traffic running in with simple engines and showing a net gain in fuel over the average number of simple engines of not less than 18 per cent., and that this record was obtained in the face of the fact that the enginemen, as a rule, do not possess the friendliest feelings toward engines of this type. During the time a close record was kept of the cost of repairs, and while it was a fraction greater than the average of the simple engines, it was a matter of insignificance as compared with a saving in fuel. He also expressed the opinion that the weight of experience is certainly favorable to the introduction of compound for all ordinary work provided the boiler is in size and capacity suitable to the engine requirements. He then dealt in an improved method of shop tools and method of handling locomotive repairs and other items of interest to the convention.

The Secretary's report showed that there are now on the roll 515 active members, 15 associate members and 18 honorary members. The Treasurer's balance showed $361.71.

The first report presented was that on the Cracking of Back Tube Sheets. The committee stated that there was an overwhelming and well-nigh universal testimony on the part of the members that radial stay boilers, carrying high pressure, are more liable to crack than other types, and that the causes of this are twofold. First, and preliminary, that cracking is due to too rigid staying of the crown sheet adjacent to the flue sheet and flange thereof; and, second, by placing flue holes too close to flanges, and possibly some of the difficulty is chargeable to the high steam pressures carried. The report was accompanied by a large number of engravings showing the methods of staying crown sheets. The report will be valuable in this respect that the dimensions are very fully given on all the drawings, but there is nothing particularly novel shown in any of the designs presented. In the discus-

sion following the reading of this report there was the usual variation of opinion in regard to the relative merits of the radial and crown bar method of staying.

The report contains an extract from a paper read by Mr. Yarrow, in which he said that there had been considerable difficulty from leaking tubes in certain locomotive boilers built for torpedo boats by his firm some time ago. The difficulty had been entirely overcome by staying the front end of the crown sheet with stays passing through a stuffing box and having a nut on the outside. Exception was taken to this method of staying from the fact that if the crown sheet expanded and was up there would be nothing to hold it until expansion was equal or the contraction had brought the nut down to a bearing at the top. There was, however, a general consensus of opinion that a too rigid staying at the front end of the fire-box was apt to result in leaking tubes. Others attributed the cause to the fact that tubes were continually rolled out, and repeated contractions and expansions caused them to wear in the tube sheet and caused the leakages. A number of gentlemen considered that a flat crown sheet was less likely to leak than others, but the testimony was so contradictory in regard to the relative merits of crown bar and radial stay that it would be difficult for an unprejudiced and uninformed person to judge between the merits of the two. In regard to the difference in expansion between the inside and outside sheets of a fire-box we would call attention to a paper printed in the AMERICAN ENGINEER AND RAILROAD JOURNAL for March of this year, showing the experiments which were undertaken by the Western Railway Company of France, to determine the difference which there is in the expansion of the inside and the outside sheets of fire-boxes. These measurements were very carefully made, and it was shown that while the inside sheet expanded more rapidly than the outside sheet while pressure was being raised, that when the boiler finally reached its working pressure the expansion of the two sheets was practically the same and the crown bars rested on the brackets bolted to the outside sheet. It might, therefore, be argued, as the result of these experiments, that the strains on the stay bolts come while steam is being generated, and not while the boiler is actually held at its working pressure. This, however, would be a matter for future investigation, and we would recommend it to the members of the Association for their careful attention in the future.

The Committee on Oiling Devices for Long Runs reported that they have received a great deal of interesting information both from the locomotive superintendents of Great Britain and this country. The practice of the English superintendents may be broadly characterized as using oil reservoirs of a high level that can, if necessary, be filled while the engine is running. They are of brass, square in plan with hinged top lid, and internally divided into sections corresponding with the number of holes, small tail pipes leading from them. In the case of axle boxes usually one to each journal and one to each jaw face. Worsted syphon trimming is common, as well as horizontal plugs for each pipe, so that the oil may not be wasted when the engine is standing between trips. In the AMERICAN ENGINEER AND RAILROAD JOURNAL for November, 1893, a description of the Corey lubricator was published. Mr. L. B. Paxson, of the Philadelphia & Reading Railroad, was the only one that advised the committee of any practical acquaintance with this device. He says that it has been in use for one year on a compound engine, and showed a saving of about 25 per cent. over the old way of oiling.

Other devices for oiling while running are reported by Mr. Stevens, of the Lake Shore & Michigan Southern Road. He supplied oil pipes from the footboard to all axle journals on locomotives drawing the Exposition Flyer, which had a continuous run of 135 miles, with the result that the entire service of these trains was performed without a single hot box. Other devices of a similar kind were reported by various members

For cylinders, slide valves and air pumps some form of lubrication by condensation displacement feed is every-day practice; but in Great Britain it is common to use in addition Furness lubricators—one for each cylinder—that come into operation only when engine is running with steam shut off. Mr. I. Holden (G. E.) remarks that the Vacuum Coy's sight feed has been superseding the Roscoe, because the latter did not readily displace the heavier and thicker oils, but that the Vacuum has the defect of increasing the feed almost double when the steam is shut off. He has tried the De Limon's double-acting sight feed, and this has such large capacity, works so economically and regularly with throttle open or shut—and with all densities of oil—that he is trying a dozen of them, the first cost of one of De Limon's being less than the combined cost of one Vacuum and two Furness, and there being a saving of two pints of oil in a run of 243 miles as compared with the use of one Roscoe and two Furness lubricators.

The only special point in the few replies mentioning tender oiling is the use of spring pads or cotton-seed hulls to continuously lubricate the under side of journals.

To briefly summarize, the replies and drawings show that modern practice for high-speed lubrication is an endeavor to deliver a small amount of oil continuously over the whole length of bearing surface. Bearing surfaces are much larger (we have yet to hear of an engine with too much wearing surface at any point). It is not judicious to trust to one oil-hole where two are possible. Cups or oil-pockets are solid (cavities in the metal) rather than separate. Grooves are liberal in number and size. The cheapest of oil is then admissible. Strainers and covers over all oil pockets are desirable.

The report was followed by an appendix of oils and oil tests, which we reprint in full.

OILS AND OIL TESTS.

The replies show that the use of Galena or other mineral oil, graduated so as to be as limpid in winter as in summer, is common American practice, whereas in Great Britain there is a marked inclination to the use of vegetable oils.

Thus Mr. Bellington uses a mixture of 33 per cent. rape to 66 per cent. of mineral oil, and in hot weather makes the proportion 50 per cent. of each. Mr. Webbe did use 90 per cent. rape and 10 per cent. mineral, but now uses 50 per cent. of each for cylinders and machinery. Mr. Johnson uses the 50 per cent. proportions, but for machinery a thinner mineral oil is used in making the mixture. Mr. Hanson (G. & S. W.) uses vacuum (mineral) oil for cylinders and rape or olive for machinery, making no difference in cold weather; and Mr. Cambie uses colza for machinery, except in very hot weather, when castor oil is used.

Mr. Ivatt uses olive for machinery and black mineral for cylinders, making no difference to suit the season, as extremes of temperature are not severe. He averages 23 pints per 1,000 miles on fast trains, and from 20 to 22 on slow freights and branch trains.

Mr. Holden's tests for oils (presumably mineral) are :

	Specific Gravity.	Flashing Point.	Viscosity.	Congealing. Point.
Machinery.....	.917	375°	2.2 at 180°	28°
Cylinders.....	.897	550°	.28 at 140°	36°

Mr. Adams' specification for cylinder oil is :

The cylinder oil should have a flashing point of not less than 500° F., open test, with a viscosity of twice that of rape of 212° F.; the specific gravity and burning point of oils will be taken into account when testing.

Specification of machinery oil. The engine oil should have a flashing point of not less than 375° F., with a viscosity of twice that of rape at 100° F., and should not oxidize or become gummy when exposed to the atmosphere. The specific gravity will be taken into account when testing.

Mr. Dean's specification is as follows :

The flashing point to be determined in each case by the Board of Trade close test.

The viscosity to be tested by Sacker's viscometer (water at 60° F. = 1).

No. 1. Petroleum for burning. A declaration is to be made on every invoice and signed by a principal of the firm in the following words : " We guarantee that the oil is well refined, and that it will not give off inflammable vapor at a lower temperature than 85° F. by the Board of Trade close test. We also guarantee that the color of the oil is 'water white,' and that the specific gravity at 60° F. is not less than 0.8 nor more than 0.805."

No. 2. Oil for gas-making. To be of suitable quality for the manufacture of gas for carriage lighting. Flashing point, 200° F. Specific gravity at 60° F., 0.84.

No. 3. Oil for cleaning. To be clear, and to give neutral reaction. Flashing point, 250° to 290° F. Specific gravity at 60° F., 0.865. Viscosity at 60° F. not more than 4.0; at 140° F. not less than 2.0.

No. 4. Oil for electric light. To be clear, and to give neutral reaction. Flashing point not less than 315° F. Congealing point not above 22° F. Viscosity at 60° F., not more than 20; at 140° F., not less than 4.

No. 5. Oil for carriage lubrication. To be pure pale mineral oil and to give neutral reaction. Flashing point not less than 330° F. Congealing point below 22° F. Specific gravity at 60° F., 0 905 to 0.915. Viscosity at 60° F., not more than 30; at 140° F., not more than 4 5.

No 6. Oil for heavy machinery. To be refined and freed from light oils, but not distilled. Flashing point not less than 220° F. Congealing point blow 20° F. Specific gravity at 60° F., 0.88. Viscosity at 60° F., not to exceed 56; at 140° F., not less than 5.

No. 7. Oil for cylinders, etc. To be pure undistilled dark mineral oil of the best quality, refined and free from light oils. Flashing point not less than 480° F. Congealing point below 20° F. Specific gravity at 60° F., 0.90. Viscosity at 140° F., not to exceed 40; at 180° F., not less than 15.

And he adds, a good lubricant for the machinery is rape, 85 per cent., and mineral, 15 per cent.

Mr. Soule's specification reads thus:

Passenger engine oil. When shipment is received a sample will be taken at random from any barrel, and the material accepted or rejected on the result of this examination. The right to test any and all barrels will be reserved. Freight both ways will invariably be paid by the shipper in case of rejection.

Passenger engine oil will not be accepted which

1. Flashes below 300° F.
2. Burns below 400° F.
3. Shows a tarry deposit when 5 cubic centimeters are mixed with 95 cubic centimeters of 88° B gasoline and allowed to stand one hour.
4. Is not free from dirt, specks, lumps, grit, water, soap, or suspended matter of any kind.
5. Contains less than 20 per cent of acidless animal oil (tallow or tallow oil preferred). Shipments containing more than 30 per cent. of tallow or tallow oil are not desired, and no increased price will be paid for them on this account.
6. Contains more than 1 per cent. of free acid.
7. Shows a cold test higher than 5° F. between October 1 and April 1.
8. Has a gravity below 26° Beaumé, or above 31° Beaumé.
9. Contains a notable percentage of paraffine wax.

Owing to the fact that some of the members were to leave in the afternoon of Tuesday, the report on the specifications for boiler steel was the next one presented. It was stated that there was a very decided difference as to the quality of fire-box steel, some of the members favoring a soft steel with ultimate strength ranging from 50,000 lbs. to 58,000 lbs., while the majority preferred a harder quality with an ultimate strength of 55,000 lbs. to 65,000 lbs., and in each case there was a difference in the chemistry.

The specifications presented for discussion are shown below:

FIRE-BOX STEEL. CHEMICAL COMPOSITION OF.

	Number 1.		Number 2.		Number 3.	
	Desired not over	Will reject over	Desired	Will reject over	Desired	Will reject
Phosphorus	0.02	0.03	.....	.03	.03	.04
Sulphur ...	0.02	0.045	.....	.03	.02	.05
Manganese.	0.5	0.50	.....	.35	.04	.55
Silicon.....	0.02	0.035	.....	.03	.02	.04
Copper.....	....	.....	.....	.04	.03	.05
Carbon ...	....	... ..	Low as possible.		.18	1's t'n .15 over .25
Tensile ...	....	50,000	.....	50,000	....	55,000
Strength ...	....	58,000	.....	60,000	....	65,000
Elongation.	....	.....	.....	.....	....	.....

Dr. C. B. Dudley, Chemist of the Pennsylvania Railroad, was called in for consultation, and gave his reasons for reducing the metalloids to the lowest possible limit. Taking phosphorus for an example, he stated that it was possible to reduce it to .02, but some of the sheets giving the highest mileage had phosphorus as high as .07. It therefore appeared unwise to insist upon the lowest possible limit when no compensating gain was apparent. As regards sulphur, this is largely a matter of fuel, the lower limits being possible where natural gas is used. As this would discriminate in favor of localities using natural gas, the limit was placed at .05 as a maximum, with .02 desired.

While manganese and carbon have both a hardening effect, it is the opinion of the committee that the hardening should be accomplished by carbon rather than by the other ingredient. Silicon is believed to have the effect of insuring solidity in ingots, although not much is known as to the condition in which it exists. Mr. Dudley advised a moderate specification giving steel makers wide limits as were consistent with the quality of the steel desired.

The committee endeavored to get positive information concerning the performance of hard and soft fire-box sheets. It had the tensile strength taken from the sheets both before and after service, from which latter analyses were made. The tensile strength varies from 77,000 lbs. down to a little over 50,000 lbs., while the mileages vary from a little under 500,000 to a little over 50,000 miles. The results of examination were quite conflicting; but when it is remembered that the treatment of the fire-boxes on the road has probably more effect upon the life than has the original quality, it was what might have been expected. It was soon seen that both hard and soft steel might be found in both the long and the short-lived boxes, and sometimes in the same box.

The weight of evidence, however, was toward steel in the neighborhood of 60,000 lbs. tensile strength giving the best results.

For several reasons the harder steel has decided advantages, namely, in better holding threads and less bagging between stay bolts. Where bagging occurs the tendency is for the holes to open on the water side and thus lessen the hold upon the bolt.

The reason for recommending a test piece of parallel section in preference to the shouldered section usually prepared is that the first-mentioned forms show a higher elongation and one which we believe represents more truly the real elongation of the sheet than does the shouldered form in which the wide ends appear to brace or stiffen the adjacent parallel section for some distance.

This point was clearly demonstrated in a series of tests in which sheets were cut up into test pieces, alternate ones being prepared to the different sections mentioned. It was found that in specimens not less than 8 in. long in tested section there was little difference in the tensile strength, but the elongation in straight pieces was markedly less than that of the other forms which gave practically similar results.

The reasons for choosing dimensions of coupon, namely, 36 in. × 2 in. in rough, of which a section of at least 8 in. between grips is to be prepared 1½ in. wide, were that such length of coupon will make two test specimens if check testing is desired, or it will furnish one tensile test specimen and one for bending and quenching tests. A specimen finished 1½ in. wide and of the thickest sheets used in locomotive boilers will be within capacity of a 100,000-lbs. test machine, and a 50,000-lbs. machine will serve for nearly all that are used. Your committee was satisfied itself by tests that specimens 1½ in. wide prepared from coupons 2 in. wide and of thickness of ½ in. do not appear to be affected by shear hardening.

The results were as below:

TEST OF ⅝" BOILER STEEL SHEARED TO DIFFERENT WIDTHS AND PREPARED TO SECTION 1½" WIDE.

No.	Rough Width.	Finished Width.	Tensile Strength.	Elongation in 8".
1.....	1¾"	1.522"	56,900	24
2.....	2"	1.522"	56,400	26
3.	2¼"	1.522"	56,300	29
4.....	2½"	1.522"	56,100	26.5

The heating and quenching test is introduced because many users of steel have no other available method of investigating the quality of steel used, and it is to be noted that in nearly all marine boiler specifications this clause is embodied with modifications.

In order to establish the identity of the test specimen, the method requiring the sheet and the test piece to be attached is preferred.

It will at times happen that the test coupon is too much warped to be prepared without some straightening. In such cases it is necessary that the manipulation shall not cause hardening of the piece. In such case we recommend squeezing cold in press or between anvil and tup of steam hammer; but it should never be done by hammering, nor should the coupon be subject to any heat treatment before testing.

No better method has been proposed of detecting lack of homogeneity in fire sheets, than that of nicking test piece on edges and bending. Laminations are thus shown when careful examination of edges does not reveal them.

SPECIFICATION.

General Requirements.—Under head of ordering, inspecting at mill, marking and shipping, no recommendations are made, for reasons that no general rule suitable for all roads can be formulated, and it is not essential for uniformity that such rule be made.

Test Pieces.—Test pieces, one from each plate, shall be in rough, 2 in. wide and 36 in long, and as nearly straight and free from twist as possible and in no case must be annealed. Each plate shall bear maker's name, either rolled or stamped. The heat number, and in addition such identification marks as may be specified by ordering road, shall be put on each plate and test piece.

When inspectors are present at mills, butt strips may be cut

from any plate, provided such sheets are represented by test coupons. Where inspectors are not at mills, they must, as far as possible, be cut from a single sheet as rolled, and each sheet cut into butt strips will be represented by a test strip. All butt strips as well as test strips shall bear the heat number.

Shear Marks.—Each sheet shall be accompanied by test coupon 2 in. × 36 in. long attached at one end to sheet. To facilitate future matching, should it be necessary, both sheet and coupon shall be stamped twice across division line with a shear mark, either round, oval or of other agreed form; which mark should be not less than 3 in. across.

In cases where one large plate is cut into several smaller ones, all represented by one test piece, the same shear mark shall be stamped across each division line in two places before shearing, so that subsequent identification may be readily performed.

Dimensions.—Plates must be of shape and dimensions ordered. Any excess in weight over that corresponding to the dimensions in the order greater than that specified in table below will not be paid for.

In computing weight of plate from dimensions, 1 cub. in. will be taken as weighing 0.2836 lb.

Allowance for overweight over that corresponding to dimensions.

For plates	$\frac{1}{4}$	in.	thick,	10	per cent.
" "	$\frac{5}{16}$	"	"	8	"
" "	$\frac{3}{8}$	"	"	7	"
" "	$\frac{7}{16}$	"	"	6	"
" "	$\frac{1}{2}$	"	"	5	"
" "	$\frac{9}{16}$	"	"	$4\frac{1}{2}$	"
" "	$\frac{5}{8}$	"	"	4	"

Plates measuring one-one hundredth of an inch less in thinnest part than that ordered, and all plates which show seams or cracks at the sheared edges, or which have cracks, slivers, or depressions in the surface, or which develop defects in working, will be rejected. Rejection on account of thinness is to be made only after measurement of the actual sheet. Test pieces being prepared from the edge of sheet are liable to be thinner than the main sheet.

Test pieces when finished will be $1\frac{1}{4}$ in. wide in test section and of full thickness of plate, and may be either parallel sided or of reduced section, and prepared either by longitudinal planing or milling. Where reduced section is adopted, the distance between bottom of fillets shall be not less than 9 in., and radius of fillets shall be not less than $\frac{1}{2}$ in. and preferably more. Elongation will be measured between tram punch marks originally 8 in. apart, and on reduced sections placed approximately equidistant between fillets. In parallel-sided sections the tram punch may be applied at more than one point to insure breakage occurring between the marks.

Special Requirements for Shell Steel.—Tensile strength, 55,000 lbs. to 65,000 lbs. Elongation not less than 20 per cent. in 8 in. Test piece having rough edges removed by filing, grinding or machining, shall, without annealing, bend over on itself both while cold and after being heated to a cherry red, and dipped in water at 80° F. without showing cracks or flaws on outside edge. No chemical requirements.

Special Requirements for Fire-Box Steel.—The majority of the committee favored specification reading as follows:

Metal is to have tensile strength of 55,000 lbs. to 65,000 lbs. with 60,000 lbs. desired and 28 per cent. elongation preferred.

The chemistry desired is: Carbon, .18; phosphorus, not above .03; manganese, not above .40; sulphur, not above .02; silicon, not above .02.

Plates will be rejected having: 1. Tensile strength less than 55,000 lbs. 2. Tensile strength over 65,000 lbs. 3. Elongation less than 22 per cent. in 8 in., and in $\frac{1}{4}$ in. plates not less than 20 per cent. in 8 in. 4. Failure to stand bending and quenching test as for shell steel. 5. Any seam or cavity more than $\frac{1}{4}$ in. long in any of the fracture of homogeneity test.

Chemical.—Carbon, over 0.25; carbon, below 0.15; phosphorus, over 0.035; manganese, over 0.45; silicon, over 0.03; sulphur, over 0.045.

Homogeneity test is made in the following manner:

A portion of the broken test piece is nicked with chisel on opposite sides alternately, nicks being about 1 in. apart. Test piece is then firmly held in vise and broken by a number of light blows, bending being away from the nicks.

Laminations more than $\frac{1}{4}$ in. long to condemn.

The object of this is to open and reveal seams due to failure to weld up, or to foreign interposed matter or cavities due to bubbles in the ingots.

The above specification is intended to be liberal in its provisions, and does not differ greatly from others that have been used, and committee believes that it will be satisfactory.

This report was signed by Messrs. A. W. Gibbs, William Forsythe, T. A. Lawes, G. R. Henderson and E. M. Roberts, while Messrs. Henderson and Roberts united in submitting the following minority report:

We agree to all the items of this proposed specification except the tensile limits of fire-box steel.

Believing that this material should be kept soft, and that a hard steel is objectionable on account of its liability to crack in service, we recommend that the minimum ultimate strength be 50,000 lbs. and the maximum ultimate strength 58,000 lbs. per square inch. Some of the members of the committee urged the plea that as the working pressure of boilers had been increased from 30 to 50 per cent. over previous pressures, and as it was unwise to thicken the fire-box sheets, that a stronger material should be used. We, however, think that an increase of strength in the steel of 10 per cent. will go but a very short way toward making up the increase in pressure of 30 or 50 per cent., especially when the risk of cracked sheets and use of a harder steel are the penalties.

We, therefore, propose to the Association that the tensile limits of fire-box steel in the new specification be altered to read from 50,000 to 58,000 lbs. per square inch respectively, and that the carbon be reduced to from 0.10 to 0.20 per cent., the elongation being 20 per cent. for $\frac{1}{4}$ in. plates and 24 per cent. for $\frac{5}{16}$-in. thick and upward in 8 in. of length.

After some discussion an amendment was introduced changing the condemning point of sulphur from .045 to .035, and with this amendment the report was adopted as the practice of the Association. During this discussion Mr. McConnell said:

"We have used in the last year in the neighborhood of 600,000 lbs. of boiler steel. We have a record extending over some ten years, and the average life of the fire boxes does not exceed with us five years. In some cases the fire boxes have been worn out in two years. Our specification has been heretofore from 60,000 to 65,000 lbs., but we believe that is too high. I do not think the same specifications for steel will answer equally well in bad water and good water. We have reduced the tensile strength of steel down to from 50,000 to 57,000 lbs., and the carbon down to not less than .13 nor above .18. We think we get better results there. The character of the water has a good deal to do with the hardness of the steel that you can use. Our water is largely an alkaline water. We have a chemist; and of every sheet of steel that comes to us we make a chemical analysis as well as a mechanical test. The largest sheets we use are 235 in. long, 109 in. wide and $\frac{9}{16}$ in. thick. That is used with the side sheet and wagon top. The sheet on some of the boilers is 114 in. wide by 186 to 196 in. long. I think it would be a mistake to have any general recommendation for steel for fire boxes for the whole country."

In reply to a question from Mr. Dean as to the reason why the committee has ignored the elastic limit of steel, Mr. Gibbs replied that, in the first place, we use very little of it; and secondly, all of the strain is somewhere near 14,000 lbs. per square inch, and that strain is so much below the elastic limit of any steel we know of that we did not consider it necessary to touch upon it. The determination of the elastic limit is a much more troublesome matter than that of the other qualities; it is necessary to put micrometers on the piece and measure each pull and the stretch, and go on that way until the stretch begins to increase faster than the strain. There is a good deal more work in it than the ordinary test. As to making the test longitudinally and crosswise, we found only one specification where that was referred to. In that case there was no difference in the tensile strength of the sheet either way. They called for an elongation of 25 per cent. pulled lengthwise, and 25 per cent. pulled crosswise. We made a little test and got about the same result—2 per cent. difference. On the matter referred to by Mr. McConnell—the tensile strength—of course we haven't got any water east of the Mississippi River that is as bad as the water he uses. We tabulated the results of 255 boxes, and got as many as possible of the fire boxes west of the mountains, where they run in a limestone country, and as far as we have gone there is nothing to show anything inconsistent with the highest return in sheets having the highest tensile strength.

Some exception was taken to this reason on the ground that the factor of safety should be based on the elastic limit.

Mr. Fox, of Leeds, England, was cited as having declared that there is no trouble in getting phosphorus and sulphur as low as .04 and .05, and this in spite of the fact that there is no natural gas to be used as fuel in that country. A case was given of a boiler that had exploded wherein the steel could be bent nearly double lengthwise of the grain, while across the same it could only be bent to an angle of about 5°

Mr. George Gibbs stated that he had a tabulated statement according to the makes of steel and the tensile strength. The average mileage is 260,000 miles for fire-box sheets. The tensile strength varies between 50,000 and 60,000 lbs.

Opinions were expressed against annealing of the sheets, on the ground that there is a great deal of difference in annealing, and the man who makes the sheet has no means of knowing what it will be subjected to if it is to be put through an annealing process. Mr. Leeds, of the Louisville & Nashville Railroad, called attention to one of the items in the specifications of his road where, if the elongation exceeded 30 per cent the tensile strength was to be increased 5,000 lbs., adding that they had obtained very good results with fire-box steel ranging in strength from 52,000 to 58,000 lbs., and that they insisted as much as possible on the elimination of every element that could act as a hardener.

At the conclusion of this discussion there was a sort of an experience meeting, wherein the topic was that of the compound locomotive. The talk was opened by Mr. Garstang, who stated that there was a compound locomotive on his road, made by the Richmond Locomotive Works, and which is illustrated and described in another column of this paper. He practically corroborated what we published in our April issue as to the saving effected by the machine. He was followed by Mr. Vauclain, of the Baldwin Locomotive Works, who cited one of their engines that is now hauling a fast express between Camden and Atlantic City, and which is scheduled for faster time than the Empire State Express, and concluded by advocating the building of boilers that would carry 200 lbs. pressure of steam.

Mr. Forney then submitted the following statement and letter, which we publish in full, and which are self-explanatory :

for maintaining fire when engine was not in service between trips. I inclose herewith a London & Northwestern folder.

Yours truly,

WILLIAM BUCHANAN.

The question was at once raised as to the relative grades on the two roads whose engines are thus compared, and it was stated that they are much the same. It was added that the London & Northwestern use a great deal of Welsh smokeless coal. It is a kind of anthracite and a slower burning coal than that used on the New York Central, but with practically the same evaporative value. Attention was, however, at once called to the fact that Mr. Webb reports that he has obtained an evaporation of 10 lbs. of water per pound of coal, whereas it is about impossible for us to get more than 6½ lbs. in this country. If, then, we make the correction based on these figures, it leaves the Webb engines still further behind than is shown in this report.

One of the advocates of the compound engine stated that it was very essential that these locomotives should be kept in the best possible state of repair, as "the little leaks and things we sometimes have will tell less with the simple engine than with the compound." Then other speakers followed with a mass of figures that in a general way tended to prove that there was a decided saving in fuel as the result of the use of the compound locomotive, and this saving ranged from 15 to 40 per cent. with about the same cost for repairs.

MR. MEDWAY submitted a statement of his experience with the compound engine for six months ending September, 1893 :

STATEMENT.

RELATIVE TO MILEAGE, SPEED AND FUEL CONSUMPTION OF NEW YORK CENTRAL RAILROAD ENGINES NUMBER 999, EMPIRE STATE 888, AND THE LONDON & NORTH WESTERN COMPOUND ENGINES "GREATER BRITAIN."

	London and North Western Engine "Greater Britain."	New York Central Engine No. 888.	New York Central Engine No. 888.	New York Central Engine No. 999.
	T.* Cwt.	T.* Cwt.	T.* Cwt.	T.* Cwt.
Weight of engine and tender in working order	77 2	89 6	89 6	91 0
Average weight of train, including passengers, baggage and mails, but excluding engine and tender	160 8	162 14	180 12	279 0
Average weight of train, including passengers, baggage and mails, and including engine and tender	237 10	252 0	269 18	370 0
Time table time, deducting stops	.76 h. 7 m.	34 h. 0 m.	76 h. 8 m.	28 h. 20 m.
Deduct time made up by engine	0 50		0 h. 53 m.	
Actual running time	75 h. 17 m.	34 h. 0 m	75 h. 15 m.	28 h. 20 m.
Total distance traveled attached to trains	3,588 miles.	1,776 miles.	3,848 miles.	1,287 miles.
" " " light	24 "		26 "	45 "
	3,612 miles.	1,776 miles.	3,876 "	1,332 "
Average speed	47.66 miles per hour.	52.24 miles per hour.	51.13 miles per hour.	45.42 miles per hour.
Total weight of coal consumed, excluding lighting up	47 tons 17 cwt.	26 tons 11 cwt.	56 tons 9 cwt.	21 tons 17 cwt.
Actual consumption of coal per mile excluding lighting up	29.87 lbs.	33.48 lbs.	32 86 lbs.	38.3 lbs.
Consumption of coal per mile, including 1.2 lbs. for lighting up	31.07 "	34.69 "	35 " †	39.21 "
Total number of ton miles, including passengers, baggage and mails, but excluding engine and tender	575,557	288,822	695,008	359,073
Total number of ton miles, including passengers, baggage and mails, and including engine and tender	852,224	447,552	1,038,619	476,190
Consumption of coal per mile per ton of train, including passengers, baggage and mails, but excluding engine and tender, at 29 87 lbs. per mile	2.979 ozs.	3.30 ozs.	2.960 ozs.	2.18 ozs.
Consumption of coal per mile per ton of train, including passengers, baggage and mails, and including engine and tender, at 29.87 lbs. per mile	2.012 "	2.12 "	1.936 "	1.644 "

* 2,240 lbs.

† On the test of 888 the consumption of 35 lbs. per mile includes the coal used for kindling at the commencement of test, and the amount used each night to maintain the fire while the engine was in the round house.

NEW YORK, June 13, 1894.

Mr. M. N. Forney, Hotel Windsor, Saratoga, N. Y. :

DEAR SIR : When at the World's Fair I picked up one of the London & Northwestern folders, giving weight, speed and fuel consumption of the *Greater Britain*, which they claim is a sister engine to the *Queen Empress*.

I have been making some tests in regard to fuel, comparing them with the *Greater Britain;* in the first test with engine No. 888, on the Empire State Express, I was somewhat surprised at the low consumption of fuel of the simple engine, and also made another test with engine No. 999, on the same train, and was still more surprised on comparing it with the compound *Greater Britain.* I then made another test with engine No 888 on the same train, running about the same number of miles as the compound. I inclose herewith the results of the last test compared with the *Greater Britain*, which I think is a favorable showing ; as you will see, we ran more miles and at a higher rate of speed than the compound. I was particular in getting the total number of passengers carried on the train, also the amount of baggage and the weight of same from the transportation department—this not including the satchels, etc., carried by the passengers in the cars. I am of the opinion that this will be interesting to you, as you will note the amount of coal is included for lighting and also

Compound cylinders, 21 31 × 26 ; simple cylinder, 18 × 24 ; steam pressure, compound, 180 ; simple, 180 ; miles run, compound, 12,794 ; simple, 19,366 ; miles per ton of coal, compound, 25.1 ; simple, 22 ; repairs, cost per mile in cents, compound, $2.75 ; simple, $1.26.

MR. MITCHELL : "We used compound engines with the object of reducing the consumption of water ; and by using them we thought we could escape two water tanks and obtain better water at another point, and prolong the life of the flues 40 per cent. and the life of the fire box thirty per cent. We have run them in fast freight service. The result shows a saving in coal, no greater repairs and the engineers prefer them to the simple engines. Two of these engines with 68-in. wheels were put in the passenger service, and when first received the consumption of coal was greater than on the simple engine. I took active steps to draft the engines properly, and now they are burning less coal than the simple engines and give good results. I can fully indorse the Baldwin compound engine as a more economical engine than the simple engine. We now have fifteen compound engines on our line, six of which are decapods."

The discussion was closed by Mr. Dean, who remarked that perhaps one of the reasons for the better showing of the New York Central engine as compared with Mr. Webb's engine was

that the former had about 2,000 sq. ft. of heating surface, while the latter had but 1,350.

The next report read was that on Locomotive Fire Kindlers; the conditions laid down for the successful kindler were:

1. There must be no oil stored in the building. 2. There must be no gravity flow toward a building under any circumstances. 3. Only so much oil must be brought into a building as will kindle the fire or fires needed; the surplus, if any, immediately removed. 4. A burner easy to handle. 5. No possibility of leaving the supply of oil on by accident or carelessness. 6. A system of fire kindling cheaper and better than that in use.

The report concluded with a description of the Leslie fire kindler as used in the shops of the Chicago, Rock Island & Pacific, the Burlington, Cedar Rapids & Northern, a full description of which is given in another column of this issue.

The report of the Committee on Exhaust Nozzles consisted of some very carefully tabulated statements of the results obtained in a shop test with an adjustable exhaust nozzle. The adjustment of the nozzle consisted in a partition that could be raised or lowered at the junction of the passages leading from the two cylinders. This partition had a vertical lift of 5 in., and its object was to increase or decrease the area of the exhaust pipe at the combining point. It was also arranged with a telescope pipe that had a vertical movement of 5⅛ in. This was to obtain, if possible, a fixed relative position between the top of the exhaust tip and the stack.

The conclusions reached, as a result of these tests, were:

1. The results show that within the limits of these experiments the vacuum is greater when the nozzle is below the center of the boiler than when above it. The extreme limits of variation of the height of the nozzle in these tests was from 1⅛ in. below the center of the boiler to 11 in. above, which corresponds to a variation from 28⅛ in. from the base of the stack at the top of the smoke arch to 16 in. from the same point.

2. It was found that the back-pressure line on the indicator cards was raised considerably when the partition in the exhaust pipe was at the lowest position and when the speed was low, especially for long cut-offs (see fig. 15). This is due to the interference of one exhaust jet with the other. It is evident that for passenger engines the position of the partition is immaterial, as there was no rise of the back-pressure line on the indicator cards at high speed for any position of the partition. The variation of the position of the partition from the top of the exhaust nozzle was from 28 in. to 15⅛ in., and the variation of one opening of the exhaust pipe at the partition was 65 to 123 per cent. of the area of the exhaust nozzle.

3. After experimenting with 13-in., 14-in. and 16-in. straight stacks and a 13-in. tapered stack of the designs shown in figs. 4 to 7 inclusive, it would appear that the maximum draft can be obtained under all conditions by using a tapered stack having easy approach at the bottom and a tapered part at the top, having a total angle of about 10°. Fig. 14 shows the general shape of such a stack. It is important that the contracted portion of the stack and the exhaust nozzle be so located that the steam will strike the stack at or below the contracted portion.

4. With this engine a 14-in. straight stack gave a greater vacuum than a 13-in. and a 16-in.

5. It was found that a variation in the position of the choke in a straight stack, arranged as shown by fig. 8, did not materially alter the vacuum when the steam jet struck the stack below the choke. (See Table VI.) But when the exhaust nozzle was raised and the choke lowered so that the steam jet struck the stack above the choke, the vacuum was materially reduced.

6. This test shows that an increase of the length of the smoke-box over and above that necessary to get in a cinder pocket in front of the cylinder saddle is unnecessary and undesirable as the long smoke-box greatly decreases the vacuum. Sufficient area of netting can be put into a smoke-box which is long enough to give room for a cinder pocket in front of the cylinder saddle.

In the discussion which followed, Mr. McConnell, of the Union Pacific Railroad, gave some interesting information in regard to the experience on his road with the straight and diamond stacks. He said: "Our cylinders are constructed on a very liberal plan. The result of the diamond stack in dollars and cents to our company has been that in 1890 we hauled 254 loaded freight cars one mile with a ton of fuel; in 1893 we hauled 260 cars with a ton of fuel; in passenger service, 1890, 119; 1893, 145 passenger cars one mile with a ton of fuel; in 1890, 2,590 tons one mile; 1893, 2,757 tons of freight one mile with one ton of coal; in 1820 our engines were all equipped with the extension front and straight stack; in 1893, all equipped with diamond stack. In 1890, expense of handling cars, including expense of motive power and car department, was 3.17; in 1893, reduced to 2.79; 1890, the passenger service was 5 cars to a train; 1893, 5.96. The freight service has also increased: 15.86 cars in a train in 1890, 17.12 in 1893. Tonnage has increased, and we have saved in one year 87,000 lbs. of coal by our diamond stack. Our flues were worn out faster with the extension front end. Our experience has been, it is more economical and we get better results from the diamond stack than extension front end."

This statement was followed by a desultory talk on the comparative merits of the long and short front ends, and about as many opinions were expressed as there were speakers, the result of which was that the committee was continued for another year, with instructions to take up and investigate the relative merits of the straight and the diamond stacks.

The committee appointed to report on the Methods of Sanding the Track stated that the probable saving that can be effected by the use of a well-designed air apparatus would amount to from 35 to 50 per cent.

According to the reports, the cost of sand in the box varies from 20 cents to $2.47, and averages $1.13 per ton. In cases where the cost is given as low as 20 cents per ton we can hardly believe that the cost of loading and transportation have been taken into account. However, taking the average cost per ton and the average amount used by each engine, as given in the reports, and figuring a saving with improved devices of one-third, which we believe to be a conservative estimate, we have a saving in value of sand alone of $17.32 a year. Adding to this the reduced wear of tires, machinery, tender and car wheels, rails and ties, and also the lessened resistance to trains, the result is strongly in favor of this method of sanding.

The committee placed particular stress upon the necessity of having the sand thoroughly dried and screened through a netting not coarser than four meshes to the inch each way, or perforated sheet steel with openings not over ¼ in. wide, as the current of air has a tendency in light feeding to blow out only the finer sand, the coarser material accumulating and in time requiring to be cleaned out by a stronger blast through openings provided for that purpose.

The experience of the committee on special shop tools coincides so closely with our own editorial experience as to be really identical. We have found that those things which attract the most attention are the wrinkles and home-made contrivances that are made by men to help themselves out of difficulties, and that these are the last things to be mentioned and shown when we are on a visit to shops. In dealing with this same spirit the committee writes:

"Your committee were somewhat delayed and inconvenienced by the failure of members to fully understand the exact nature of the subject to be reported upon, many thinking that we desired to get information in regard to patented and manufactured devices only, and that the many handy and useful tools gotten up in their shops were not to be included. Several members writing us that they had no tools purchased with a view of meeting special work, but had gotten up in their shops at different times many useful tools to meet certain classes of repairs on locomotives, but they did not suppose we wanted them, as they were of the opinion that all other shops had been driven by necessity to provide just such things; however, when we got it fully understood with them, we were very much pleased with the result. In this way we have succeeded in bringing out from under the work benches and back corners of tool-rooms, etc., a great many things of interest, a majority of which can be fitted up in any well-regulated shop at a nominal cost, and without having to order much, if any, new material, and certainly without having to make requisitions for new tools. Many of these devices are the result of bright mechanics and foremen being forced to accomplish much with small resources, others are the result of study on the part of mechanical engineers and draftsmen connected with repair shops, with a view of meeting otherwise difficult jobs with dispatch and economy."

The remainder of the report is taken up with a discussion of the value of hydraulics and compressed air as a means of driving special tools, concluding with a long list of such tools that were furnished to the committee by the several members.

The Committee on the Cost of Maintaining Locomotive opened their report with the statement that it early realized the difficulties in the way of presenting facts and figures to the Association that would be valuable and conclusive. Besides, the figures on performance sheets do not always give the true cost of maintaining the locomotives reported on them, and an intelligent comparison of costs of repairs on different roads is almost impossible because of the various items of expenditure which are often improperly added to or omitted from the account. This difference in the methods of accounting is not chargeable to the mechanical department, but arises from the lack of uniformity of opinions in the accounting departments of the roads.

Besides the methods of keeping accounts there are many other reasons why a comparison of performance sheets is liable to be misleading. The repair account often fluctuates greatly from causes entirely beyond the control of the mechanical or any other department—as, for instance, by the necessity for retrenchment, which may greatly reduce the expenses of the department for a time, only to swell them to unusual figures at a later period. We all have examples of that in the management of railroad properties in the last year. Then, again, the filling of many vacant numbers during one year will cause a bulge in expense of repairs (if charged to this account) which naturally would have been distributed over a longer period.

In addition to all this there are physical characteristics of the road to be considered, the methods of operation and the character of the motive power. The expense of repairs per engine mile for an eight-wheeled locomotive is almost invariably less than for ten-wheeled mogul or consolidation engines, and the road which has a plentiful sprinkling of the latter in its equipment is certain, all other things being equal, to show a higher cost of repairs per engine mile; if the records were made up on the ton-mile basis the result might be quite different. The character of fuel and water also has a marked effect on the cost of repairs, and the effect of heavy grades and curves are too well known to require comment. The speed of trains has a greater influence on the cost of maintenance than is generally supposed. Your committee might cite many cases to show the expense of high speeds, but probably a case that recently came under its notice will suffice. The time of a train scheduled to make 100 miles in 4½ hours, with 6 cars and 27 stops, was reduced to 4 hours, and immediately the fuel bill for that train was increased $100 per month with the same engine and men; and when the running time was changed back to 4½ hours the fuel record at once dropped to its old figures. On the same road it is found that the eight-wheeled engines in fast passenger service cost more for repairs than ten-wheeled engines in ordinary freight service, and no amount of care will bring the expense of the fast eight-wheeled engines below the slower ten-wheeled. The average cost of repairs is also greatest on those divisions whose train speeds average the highest.

From a consideration of all these facts it is evident that no intelligent and exact comparison of performance sheets is possible without an intimate knowledge of all the circumstances and conditions existing during the period covered by the statements, and the difficulties in the way of any work of this committee, based on performance sheets, is made apparent.

A special feature of the subject assigned to us, and the one to which we understand we are to devote our attention chiefly, is the comparison of the cost of maintenance of locomotives built in contract shops with those built in railroad shops. In the circulars your committee issued, members were asked for their opinions and also for figures bearing on this point. We received in reply many opinions and few figures. Some of the members had no experience with contract and railroad-built engines under conditions suitable for comparison, but were of the opinion that the engines turned out of the railroad shops were less expensive to maintain; a few could find no difference, while the majority had found by data collected some time in their experience that the railroad-built engines were cheaper to maintain, the difference in their favor evidently varying from a trivial amount to figures of considerable magnitude. But no opinions or figures were received which would show that in a single case contract-built engines had proved less expensive to maintain than those built in railroad shops. Few of the members furnished actual figures, however, and your committee have not been able to get much exact data, because of the great amount of labor that is entailed in going back over old records and sifting out the desired figures, and for the further reason that in some cases there are objections to making the figures public.

Actual figures have been furnished only by members of the committee itself. Mr. Barr contributes the following: "I give you herewith the average cost of repairs for the first fifteen months of eight of our Class B eight-wheeled engines, built in a contract shop, and six of the same class of engines put in service at the same time and built in our shops. The average cost of repairs for the eight contract-built engines was 2.028 cents, and the average cost of repairs for the six engines of the same class built in our own shops was 1.155 cents. The only other comparison we can make between engines on equal footing is the case of one of our Class C engines, which is a six wheeled switcher that has been in service two and one-half years. The average cost of repairs during that time has been 2.29 cents; nine contract engines of the same class bought at that time have cost on the average 3.45 cents. I have no hesitation in saying that the cost of repairs for the first three years of engines built in our own shops is much less than for engines built in contract shops."

It may be profitable, in connection with this subject, to turn attention to some of the means by which the cost of repairs may be reduced. There are many shop practices and methods of conducting the business of the mechanical department which have their effect upon the cost of repairing locomotives, and to which reference can appropriately be made in this report. The importance of centralizing the work of heavy repairs in one or more large shops on the system, well equipped for doing such work economically, should not be lost sight of. Heavy repairs conducted in small and imperfectly equipped shops not only cost more than at the main shops, but require more time and keep the engine out of service for a longer period than is necessary. This is a serious matter when there is sufficient business to keep all the motive power moving. The only circumstances under which repairs made at small shops would be cheaper than at the main shops would be when there was a large difference in the rate of wages in favor of the small shop. Certain work, however, can be done economically and quickly in the small shop, when the latter is supplied from the main shops with those finished parts for which it has no facilities.

As to whether a road should have more than one large plant will depend wholly upon local conditions, and your committee does not propose that one plant of mammoth proportions should necessarily do the repair work for a large system. But, unless unusual conditions exist, a second plant for heavy repairs should not be considered until the first has become large enough to warrant the installation within it of first-class tools, and every convenience by which the cost of the work will be reduced. This having been achieved, and a greater output being desired, it is a question, depending for answer upon local conditions, whether the increased capacity be obtained by enlarging the plant or building a second one, with the expectation that in a short time it will also be large enough to warrant the installation of a large amount of labor-saving machinery.

In conducting repair work two important considerations should always be kept in mind—the actual cost of the repairs, and the time the engine is kept out of service in making them. Not many years ago comparatively little was done toward the work of repairing an engine before it entered the shops. Now, the time the engine is idle is greatly reduced by keeping on hand, in a partly or wholly finished condition, many such parts as are liable to be needed. Numbers of these parts are standard for all locomotives on the road, and are made without any reference to which engine they will finally be used on; others are more special in character, and may be made for a certain class of engines or even for individual locomotives. Undoubtedly the perfection of this policy will effect still further economies, for not only is the repair work facilitated when the engine comes in, but the parts made in advance of the time are turned out at a reduced cost because the labor on them is performed at such times as it can be done cheapest and most conveniently.

One great source of expense is the repairs which are almost invariably made, whether actually required or not, when an engine comes in the shop to have its tires turned. When the wheels are removed it seems almost impossible to prevent the expenditure of labor upon parts whose condition gave the master mechanic no concern, and on account of which the engine certainly would not have been brought into the shops. Of course, if such refitting is done after careful inspection and with the conviction that the engine can be kept out longer before undergoing a thorough overhauling, the expense may be justified; but your committee is convinced that in many cases the expense is incurred simply because good mechanics cannot resist the temptation to make such parts "just right" before they leave them.

To avoid this expense, and at the same time reduce the number of hours an engine must stay out of service to have its tires turned, a number of roads are keeping turned tires on hand for each class of engines, and when an engine comes in, its tires are taken off the wheel centers without removing the wheels from under the engine, and the newly turned ones shrunk on in their places. The engine is then ready for service in not more than ten hours from the time it entered the shop, and the cast-off tires are turned at the convenience of the shop and held for the next engine of that class which may come in for tire turning. This plan interferes somewhat with tire records, but is most excellent, nevertheless.

Some railroads are carrying out this policy of having new parts all ready for an engine that comes in for heavy repairs, even to the extent of having a boiler entirely ready instead of waiting to repair the original one. Having one extra boiler for a certain class of engines, many of which are approaching the time when extensive boiler repairs will be necessary, the old one is removed, the extra boiler substituted, and the former repaired at leisure, to be put into the next engine of the same class requiring heavy repairs.

It is not the purpose of your committee to argue that this method of procedure can be carried on indefinitely; but if it is the settled policy of the mechanical department to forestall the day of heavy repairs by doing beforehand such work as can be performed with certainty and profit, it will result in keeping the shops more uniformly employed, and in reducing the cost of heavy repairs. A limit to this method of working is reached when the interest on the capital locked up in repair parts awaiting use becomes so great as to counteract the saving effected, but this will never occur when the repair work is judictously managed.

The standards adopted by a railroad, unless their introduction is carefully watched, may incidentally increase the cost of repairs. Standards are desirable, but their purpose is to reduce expenses and not increase them. Those making repairs should be instructed not to substitute new standard parts when it is possible to refit or repair to advantage the old parts, even if they are no longer standard, true economy in repairs being the ruling idea rather than the pushing of certain standards. Unless this is done, much money will be wasted by the substitution of new "standard" parts for worn parts that are still suitable for service. This matter should be followed closely, as even when the orders concerning the introduction of standards are beyond criticism, the shop in acting upon them is liable to get into expensive ways.

Your committee is also impressed with the fact that the running repairs are frequently not conducted economically because of the absence of facilities at small outlying points, and the lack of care in keeping such places stocked with the supplies and stores they require, and only those. Thousands of dollars are locked up in supplies at these and larger points that have gradually accumulated and for which there is seldom any demand. The stock at each place should be kept as low as possible, and yet it should be of such a character as will fully meet the demands at that point. The endeavor should be, in the main, to avoid making at these small places anything which can be manufactured at the large shops and shipped to them to be kept in stock.

The committee in its circular asks members to state whether they considered their round-houses properly equipped for running repairs, and few of those answering were able to say that theirs were. It is a matter of regret that managements do not realize more fully the economy of proper expenditures on small tools for these points. From the answers of members it appears to be the consensus of opinion that the tools required for running repairs at outlying points where the number of locomotives cared for is about twenty-five, are as follows: One boiler and engine, one lathe, one planer, one drill press, one bolt cutter, one blacksmith's forge, one grindstone, one complete set of hand tools.

This list is subject to some modification according to whether the number of locomotives is greater or less than noted above, and to meet local conditions. But the needs of small points on the road should be carefully studied and ample facilities and suitable supplies provided for them. It will pay in the reduced cost of such repairs as are actually made, and will make it more certain that the stitch which saves nine will be taken in time.

The Committee on Tire Treatment was appointed to report with recommendations diameters for wheel centers greater than 66 in. From the answers received to the question regarding the shrinkage to be allowed per foot of diameter for each size of wheel larger than 56 in., it is found that a majority of the members are using either the Master Mechanics' standard, $\frac{1}{8}$ or $\frac{1}{16}$ in. per foot in diameter of center for shrinkage, and would recommend that these allowances be followed on the larger centers, when future experience will demonstrate the proper shrinkage to use, and the Association will be in a position to recommend the correct amount of shrinkage for all diameters.

In the opinion of the committee, the retaining ring is only put on as a means of safety, to prevent accidents from loose or broken tires; consequently we do not consider it advisable to recommend that tires could be run thinner with a retaining ring than without.

Your committee would recommend the same shrinkage as used for each size of wheel center without retaining rings, for the reason that if retaining rings are used they have been applied to give increased safety.

Concerning the thickness that tires should be considered safe at last turning, your committee find the recommendations vary from 1¼ in. to 1⅝ in. for passenger service, from 1¼ in. to 1⅜ in. for freight service, and from 1 in. to 1⅜ in. for switching service. After a careful consideration of this subject we would recommend the limit on passenger tire be placed at 1¼ in. for last turning, and the limit on freight and switching tires be placed at 1¼ in. for last turning. The weight on drivers not to be considered, and no distinction made between engines equipped with driver brake and those that are not.

Your committee believe the wear on tires should not exceed ½ in. in depth before turning on road engines and ⅝ in. in depth for switch engines. We believe the conditions of traffic on railroads govern, in a great measure, the depth tires are worn; for instance, if power is badly needed, engines are often run when the tire should be turned. While we recommend and believe the above limits are good practice, we do not believe an arbitrary rule could be carried out at all times, as the business on a road regulates the number of engines that can be spared from service for tire turning. We believe if above practice were carried out, it would be equally advantageous to the engine and the track.

The last report presented was that of the Committee on Conducting Locomotive Tests. As this committee worked in connection with a similar committee appointed by the American Society of Mechanical Engineers and the report presented is a reprint of the one read before the latter society at its meeting in Chicago last summer, which has already been published in its Proceedings, it is unnecessary to give a *résumé* of it here.

At the session on Wednesday, June 20, the following officers were elected for the ensuing year: President, William Garstang, S.M.P., Cleveland, Cincinnati, Chicago & St. Louis Railroad, Indianapolis, Ind.; First Vice-President, R. C. Blackall, S.M.P., Delaware & Hudson Canal Company, Albany, N. Y.; Second Vice-President, R. H. Soule, S.M.P., Norfolk & Western Railroad, Roanoke, Va.; Secretary, Angus Sinclair, 256 Broadway, New York; Treasurer, O. Stewart, Cambridge, Mass.

STANDARD MOGUL PASSENGER ENGINE, DELAWARE & HUDSON CANAL COMPANY.

In our last issue we published a description of a standard freight mogul engine, as built by the Delaware & Hudson Canal Company at the Oneonta shops, under the direction of Mr. R. C. Blackall, Superintendent of Machinery. We now publish similar illustrations of an engine designed and used in passenger service, which is giving equally good results. The cylinders are of the same size—namely, 18 in. × 24 in.—as those used in the freight engine, but it will be seen from a comparison of the outline sketches that the weights and sizes of the passenger engine are considerably greater than those of the freight. For example, the length of the tender is 18 ft. 7 in. instead of 17 ft. 3½ in.; the weight of the same has risen from 62,900 lbs. to 75,300 lbs.; the diameter of the boiler is 55½ in. instead of 50 in., and contains 235 flues 11 ft. 11 in. long, instead of 204 flues 11 ft. 7½ in. long; the diameter of the drivers is 63 in. instead of 57½ in., and the weight on the same is 109,800 lbs. instead of 86,930 lbs., with practically the same weight on the truck—namely, 13,225, as against 13,070 lbs.

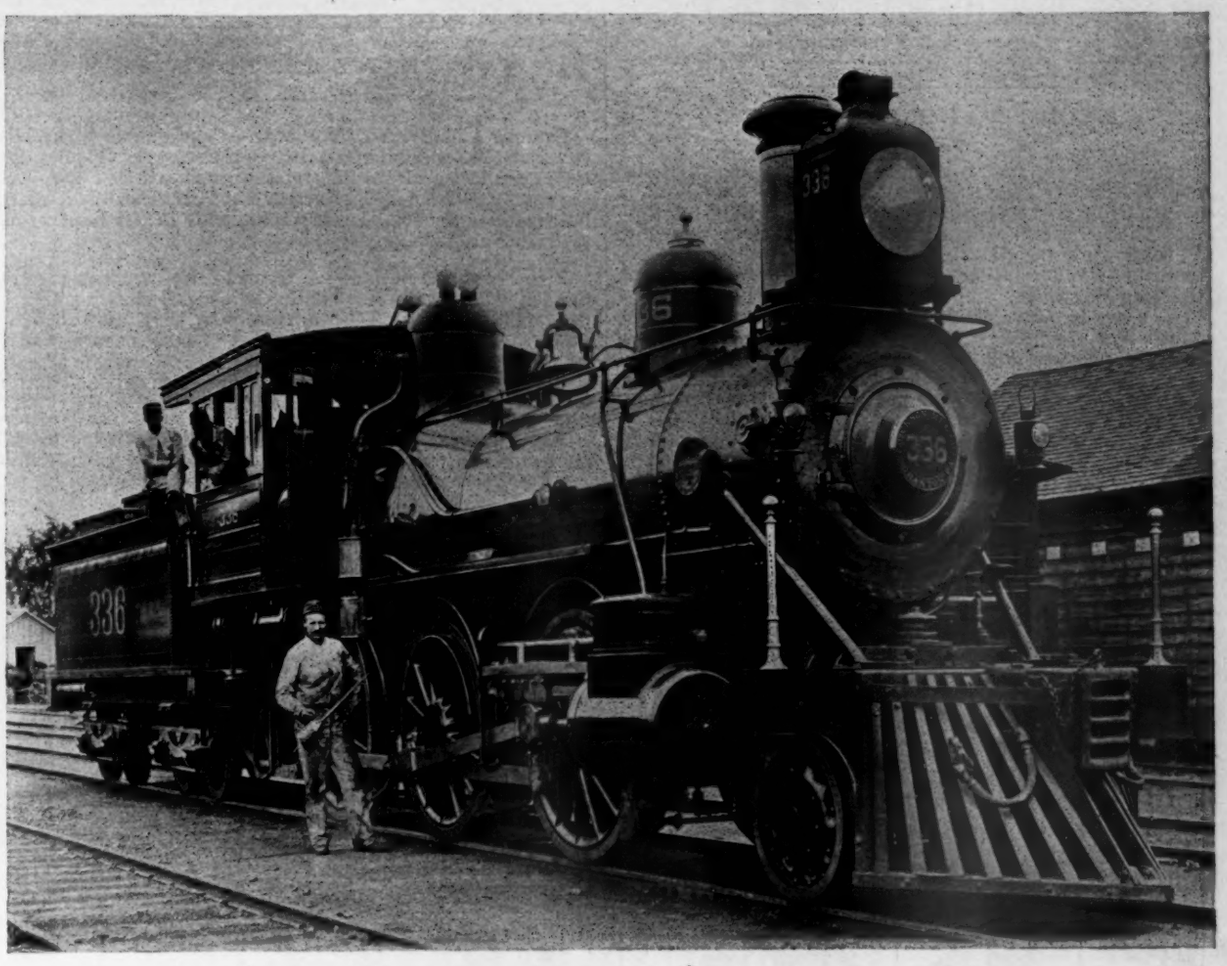
Making a similar comparison in the valve motion, we find that the steam-port is 1¼ in. × 17¼ in. instead of 1¼ in. × 16 in., with an exhaust of 3 in. × 17¼ in. instead of 2¼ in. × 16 in. The inside laps of both valves are line in line.

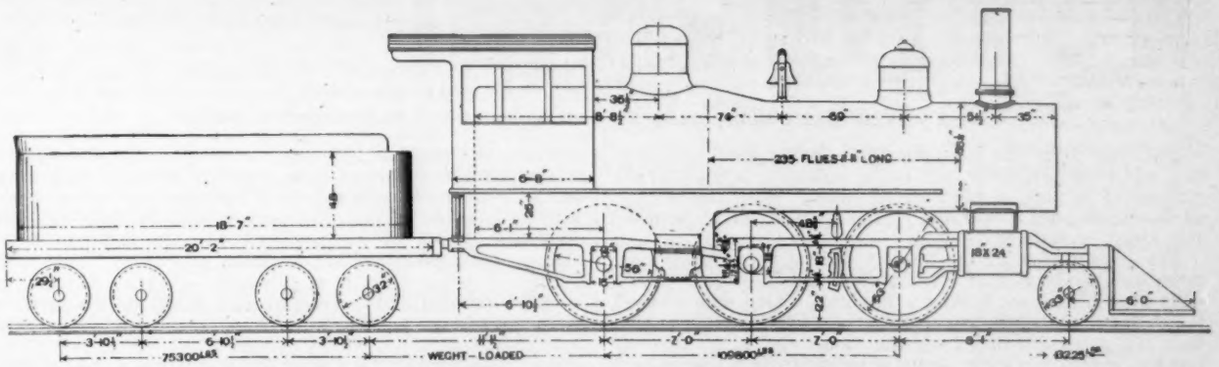
The work of these engines, if carefully watched, will go very far to remove the prejudices which have always existed against the utilization of mogul engines for passenger traffic. Men seem to be afraid of the pony truck at high speed, and yet we know of no instance of derailment that was due to the use of the pony truck. The following are the principal dimensions of the engine:

Kind of fuel used	Anthracite.
Gauge of road	4′ 8½″
Total weight of locomotive in working order	123,025 lbs.
" " on drivers	109,800 "
" wheel base	22′ 1″
Distance between front and back drivers	14′
" from center main driver to center cylinder	53″
Length of fire-box	126″
Width " "	42″
Depth " " (front)	5′ 3″
" " " (back)	4′ 1½″
Water space, side of fire-box	3½″
" " back " "	3½″
" " front " "	3½″
Material of outside of shell	Otis steel.
Thickness of plates outside of shell	7/16″
Material of inside of fire-box	Otis steel.
Thickness of plates inside of fire-box	3/8″
" " " back end	7/16″
" " crown plate	3/8″
Material of tube plates	Otis steel.
Thickness of front tube plates	5/8″
" " back " "	7/16″
How crown plate is stayed	Riveted to bars.
Diameter of dome	27½″
Height of dome	25″
Maximum working pressure per sq. in	150 lbs.
Kind of grate	Water grate.

Width of bars	2"
" between bars	1"
Grate surface	36.75 sq. ft.
Heating surface in fire-box	172.5 "
" " inside tubes	1,283 "
Total heating surface	1,455 "
Single or double blast nozzle	Double.

Greatest travel of slide valve	5⅝"
Inside lap of slide valve	Line and line.
Lead of valve, full stroke (front)	¼"
" " " " " (back)	⅛"
Throw of upper end of reverse lever from full front to back	.57"
Sectional area of steam pipe to cylinder	27½ sq. in.





STANDARD MOGUL PASSENGER ENGINE, DELAWARE & HUDSON CANAL COMPANY.

Diameter of blast nozzle	2⅜"
Smallest inside diameter of chimney	16¼"
Height from top of rail to top of chimney	14' 4½"
" " " " " " center of boiler	7' 6"
Weight of tender empty	44,300 lbs.
Number of wheels under tender	8
Diameter of tender-wheels	33"
Size of tender-journals	3¼" × 7"
Distance from center of main driver to center back driver	7'
Length main-rod, center to center of bearings	7' 4½"
Transverse distance center to center of cylinders	6' 10½"
Diameter of cylinder and stroke of piston	18" × 24"
Horizontal thickness of piston and follower plate	5"
Kind of piston packing	Cast-iron.
Diameter of piston-rod	3¼"
Size of steam-port	1½" × 17½"
" " exhaust-port	3" × 17½"

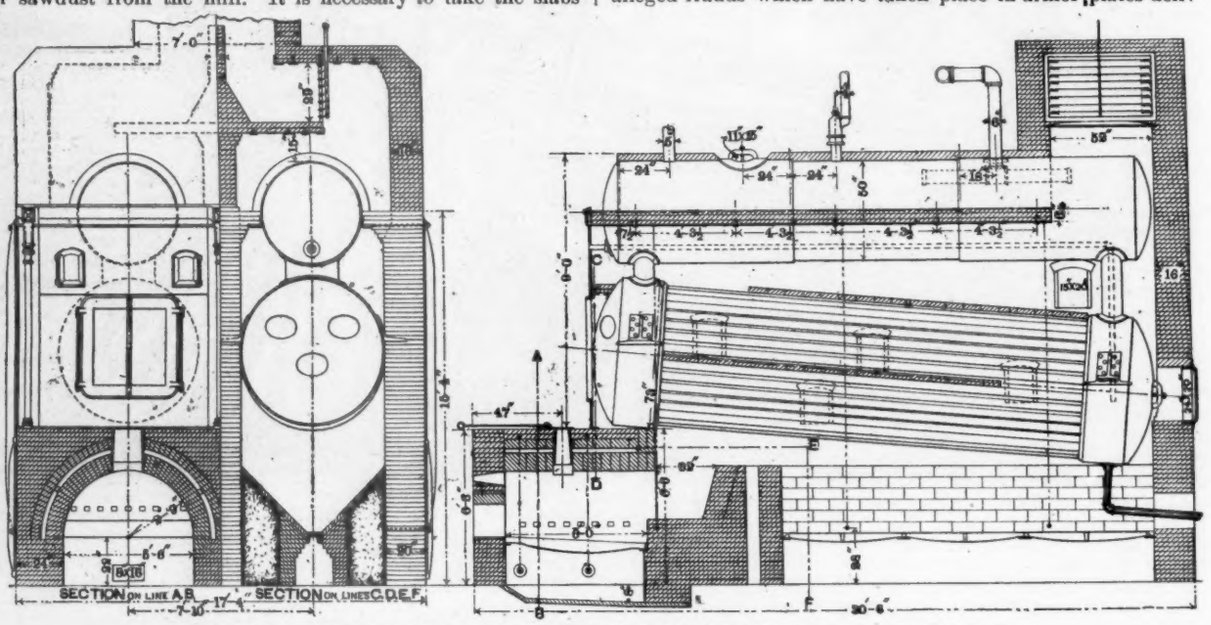
Diameter of driving-wheels outside tires	63"
" " front truck-wheels	33"
Size main axle journal, diameter and length	8"
" other driving axles	8"
Diameter of truck axle journals and length	5½" × 10"
Size main crank-pin journals	5" × 5"
" coupling-rod journals (main)	5½" dia. × 4"
" " " (front and back)	4" dia. × 3½"
Length of driving springs, center to center of hangers	35"
Straight or wagon top	Wagon top.
Material of barrel of boiler	Otis steel.
Thickness of plates in barrel of boiler	⅞"
Kind of horizontal seams	Double-riveted lap with welt.
" " circumferential seams	Double-riveted lap.
Material of tubes	Iron.

Number of tubes	235
Diameter of tubes outside	2"
Distance between center of tubes	2¼"
Length of tubes over plate	11' 11"
Total wheel-base of tender	14' 7½"
Distance from center to center of truck wheels	3' 10½"
Water capacity of tank in gallons of 231 cu. in.	3,300.
Coal capacity of tender	5 5 tons
Total wheel-base of engine and tender	47' 10"
" length of engine and tender over all	57' 6"
" " " " " " " " including draw castings	59'

WOOD'S WATER-TUBE BOILER.

APROPOS of the recent discussion by the members of the American Society of Mechanical Engineers, in New York, a comparatively new type of water-tube boiler will be interesting. This boiler is illustrated in the accompanying engraving, and is known as the Wood's boiler, and is controlled and built by Wickes Brothers, of East Saginaw, Mich., for the States of Michigan, Wisconsin, Minnesota, Indiana, and Illinois.

The boiler is shown in the setting, known in the saw-mill country as a Dutch oven, which is arranged for burning the refuse from the saw-mill using band saws. The sawdust from these saws is very fine, and when coming from certain kinds of timber, such as hemlock and hard woods, it is very difficult to burn, and mills using tubular boilers set in the ordinary manner have great difficulty in making steam with the refuse or sawdust from the mill. It is necessary to take the slabs



WOOD'S WATER-TUBE BOILER, MADE BY WICKES BROTHERS, EAST SAGINAW, MICH.

which come from the logs, pile them in the yard until they dry, and then haul them back to the boilers to be used for the purpose of helping to burn the sawdust. With this setting, as shown, the mill is operated by the sawdust refuse from the mill alone, no slabs being used.

The construction of the fire-box will be very readily seen from an examination of the drawing, and it consists practically of a brick oven, having a fire-brick lining with no cooling surfaces whatever. The temperature of this oven is so high that the gases distilled from the damp and green fuel are quickly ignited and burn, and this temperature is also so high that there is no smouldering and bedding down of the fuel. After leaving the fire-box proper, the gases pass over a bridge wall and back to the back end of the water-tubes, passing up around them, and thence to the front and then back beneath the steam and water-drum to the stack. This course is readily traced from the engraving. The combustion chamber back of the brick wall is of V-shape, as shown in the right hand cross-section, so that all accumulations, ash, and soot are very readily removed and spaces kept clean.

The boiler consists of a nest of water-tubes expanded into cylinders with dished heads, and connected at either end with water legs extending up to a drum 50 in. in diameter, which is partially filled with water, the steam space being at the top. The circulation is very rapid in the tubes, so that little scale is allowed to form, and this is materially assisted by the large amount of water carried in the cylinders at the ends of the tubes. Very dry steam is also obtained from the boiler on account of the large capacity of the dome and the large liberating surface of water. A number of evaporative tests show that they compare very favorably with other well-known water-tube boilers of similar type.

NOTES AND NEWS.

Cramps and British Warships.—Considerable interest is being manifested by the fact that the Cramps are bidding for the construction of British warships, and whether they get the contract or not is significant that American builders are now entering the field in competition with British builders on their own grounds.

Fire-Proof Insulation.—A German electrical paper gives the following recipe for painting electrical wires, making a fire-proof insulation. The proportions by weight are about as follows: Forty magnesia, 28 tallow, 15 pulverized asbestos, 30 liquid glue, 15 glycerine, and one-quarter chromate of soda or potassium; to this may be added an additional one-quarter of lampblack if it is desired to make it black.

The "Monteroy's" Plate to be Drilled.—Owing to the alleged frauds which have taken place in armor plates delivered by the Carnegies, it is now reported that the armor plates of the monitor *Monteroy* are to be drilled with a view to making an examination for defects. They are now being examined and photographed. There are to be in all 28 photographs of plates; these will be numbered and the location of the alleged faulty plates marked on them.

Experimental Naval Tanks.—In a recent annual report of the Chief of Construction it was recommended that an experimental tank be added to the equipment of the naval service. These tanks are used for towing the model of a proposed ship, and consist of a long, narrow basin. The tank recommended will be, if made, from 300 to 500 ft long, about 20 ft. wide, and 9 or 10 ft. deep, having a runway over the centre, from which the model can be towed at any desired speed.

The "Minneapolis."—The preliminary builders' trial of the United States cruiser *Minneapolis* was made early in June with results that were most gratifying. The fuel used was anthracite coal, which served to handicap the vessel to some extent, but in spite of this the reports of the trial show, by the patent logs, that a speed of 21.75 knots had been made. The maximum number of revolutions of the shafts was 138 per minute with 160 lbs. of steam per square inch. It is expected that the official trial will take place at some time before the 15th of this month.

Mahogany Pavements in Paris.—One of the London papers reports that mahogany streets are being laid down on a portion of the Rue Lafayette, in Paris. The blocks used are of real Brazilian mahogany of peculiar fine texture and color. It is an experiment, as the wood is much more expensive than that ordinarily used for the same purpose. The actual cost of the new road will be 50 francs, or about $10 per square yard. It is hoped that the extra outlay will be more than compensated for by the greater durability.

Drainage Canal for the City of Mexico.—The City of Mexico, it is now hoped, will be as healthful for the future as it is beautiful in location. The 30-mile canal with the additional 7 mile tunnel driven through the western mountain range, by which a proper sewerage for the city is at last to be gained, and danger of inundations removed, was formally opened last month. President Diaz, in the presence of the Cabinet and many distinguished men, finished the opening with a silver pick. Then there were informal exercises of rejoicing.

Restoration of Purdue Laboratory.—The restoration of the Purdue Laboratory at Lafayette, Ind., recently destroyed by fire, is being pushed forward rapidly. The locomotive *Schenectady* has been returned to the university from the Pan Handle shops at Indianapolis, where it was put in thorough repair. The engine was backed in over the new track into the Annex laboratory, and directly upon the carrying wheels of the testing apparatus, all under its own steam. This indicates the ease with which the new Annex laboratory may receive any locomotive for testing.

French Railways.—A Paris correspondent of the London *Times* gives an account of the French Railway system. It appears that M. De Freycinet induced the government in 1883 to guarantee to the great railways their average dividend on condition that they would construct an immense network of small railways, their outlay on which was also guaranteed. The work has been executed and has been of great benefit to France, but the treasury and the tax payer are suffering. There is an annual deficit on the general railway account that has risen to $23,200,000 this year, and next year will be $27,000,000. The railways have therefore become a source of perplexity to French ministers of finance.

Electricity in Lighthouses.—It has been decided by the Lighthouse Board that electricity shall be installed as the illuminant at the Fire Island Lighthouse. An appropriation of $15,000 has been allowed for the purpose. The great lens constructed by Lepante, of Paris, and recently exhibited at the Chicago Fair, will be used with the electrical arc installation. This lens was purchased by the Treasury Department for $10,000. Fire Island will thus be the first lighthouse in the United States illuminated by electricity, with the exception of the small beacon on the north point of Sandy Hook. Electricity has, however, been used for some time in lighting buoys in Gedney Channel.

Boring 8,000 Ft. through Rock.—The deepest borehole of the earth is the one at Poroschowitz, in the Rybnik District, Upper Silesia. It has been carried to a depth of something beyond 2,000 meters (about 67,000 ft.), and the diameter of the tube at the bottom is 7 centimeters. Boring to such a depth, and, moreover, through solid rock, was almost impossible prior to the invention of the Mannesmann tube. The greater strength of this tube, as compared with others, makes it possible to use tubes of thinner gauge. It is expected that a final depth of yet another 500 meters (some 1,670 ft.) can be reached, and a number of interesting observations on temperature, etc., will be made.—*Engineering.*

New Smokeless Powder.—A new smokeless powder, discovered by Mr. Leonard, a Virginian, is being experimented with by the authorities of the Naval Ordnance Bureau. In a test made with it a 33-lb. projectile was used with graduating charges. With a charge of 7 lbs. a velocity of 2,054 ft. per second and a pressure of 8 tons at the muzzle was secured; while with 9 lbs. a velocity of 2,300 ft. and a pressure of 11 tons resulted; 11 lbs. of powder gave a velocity of 2,537 ft. and a pressure of 14 tons; and the highest charge used—that is, 12 lbs.—gave a velocity of 2,736 ft., with a pressure of 17.8 tons. The powder is manufactured in solid sticks 24 in. in length by $\frac{1}{4}$ in. in diameter. Recommendation has been made by Captain Sampson for the appropriation of $50,000 to be used for further trial of the powder. The Army has recently purchased 5,000 lbs. for the new small-service arm, and it is said it will be adopted in service.

Damage to the "Resolution."—The London *Times* states that the repairs to the *Resolution*, which was recently caught in a hurricane in the Bay of Biscay, will cost $15,000. At the time of the gale the mess-room and cabin of the ship were knee-deep with water. The *Resolution* labored and strained heavily, and it was feared she would capsize. Her doors were smashed and rivets loosened; then the vessel began to leak badly. Several of the crew were injured. It is claimed that the inclination of the decks reached 35°.

Test of Rapid-fire Guns at Sandy Hook.—The following is the record of the tests of the rapid-fire guns made at Sandy Hook on June 1:

Driggs-Schroeder 6-pdr.—Number of rounds fired in 1 minute, 34; rounds fired in 3 minutes, 88; time to dismount block, remove main spring, rear spring and firing-pin, extractors, one round fired at beginning and end, 2 minutes, 4$\frac{1}{5}$ seconds.

Hotchkiss—Number of rounds fired in 1 minute, 28; rounds fired in 3 minutes, 83; time to dismount block, remove main spring, rear spring, firing-pin, etc., 1 minute, 37$\frac{2}{5}$ seconds.

Skoda 3-pdr.—Number of rounds fired in 1 minute, 24; rounds fired in 3 minutes, 55; time to dismount block, etc., 33$\frac{2}{5}$ seconds..

Sponsel—Number of rounds fired in 1 minute, 24; rounds fired in 3 minutes, 73.

Maxim-Nordenfelt—Number of rounds fired in 1 minute, 20; rounds fired in 3 minutes, 65; time to dismount block, etc., 3 minutes, 33$\frac{2}{5}$ seconds.

Turrets of the Monitors.—An inquiry has recently been made by the Navy Department as to the efficiency of the turrets of the latest vessels, especially that of the *Monterey*. The report on their performance has been submitted to the department by Captain Kempff, in which he states that while crossing the bar on the trip going out from San Francisco, the vessel ran constantly in the trough of the sea, but gave no greater angle of roll than 16°. Under these circumstances there was a very slight sliding motion of about $\frac{1}{4}$ in. of the turret. No blow was brought, however, against the flanges of the rollers, and the turrets showed no sign of lifting on the weather side. The period of roll of the *Monterey* is three seconds, but is not at all jerky. The next day in a rough sea the ship was run in the trough for over half an hour. In the forward turret the greatest sliding motion was $\frac{7}{16}$ of an inch, with an average of $\frac{1}{8}$ in. At the same time there was a slight rotary motion. The motion was taken up easily and gradually. While rolling from 9° to 14° the turrets were kept in constant motion from extreme train starboard to extreme train port, and the revolving machinery with the usual pressure of 600 lbs. worked the turrets in this condition as regularly and easily as though the vessels had been at anchor in a good harbor. The turret was worked full speed and also slowly, and was at all times under perfect control. The report concludes by stating that there will be no trouble in firing the battery on the *Monterey* in what is generally termed a rough sea. After arriving in port the roller flanges and roller paths were again examined and found in perfect condition.

Specifications for Steel Castings.—Mr. H. L. Gantt, of Philadelphia, has issued a circular regarding the specifications for steel castings, in which he gives the minimum and mean requirements in 2-in. test bars for the two grades of steel castings used by the United States Army in the manufacture of gun carriages. The following table gives the data:

Metal.	Mean.		Minimum.	
	Tensile Strength.	Elongation.	Tensile Strength.	Elongation.
No. 1	60,000	18 %	55,000	15 %
No. 2.....	70,000	14 %	65,000	10 %

And as a proof that these requirements are not excessive, he quotes the following actual tests which were made from castings delivered to the Army and Navy Department.

Name of Casting.	Weight.	Tensile Strength.	Elongation.
Roller path for 8" gun carriage.....	7,995	73,000	33.20%
Chassis for 8" gun carriage.....	13,500	69,500	31.60%
Stern frame for U. S. Cruiser No. 11....	9,213	65,174	32.20%
Box slide for 12" turret mount	15,000	65,000	25.00%

The tensile strength is given in pounds per square inch, and the elongation is the percentage of increase in the length of

the bar before rupture. The objections to depending wholly upon test bars for an indication of the quality and homogeneity of the metal in a casting are numerous; among which may be noted that to test a very large casting thoroughly by this method, several bars should be taken, representing different portions of the casting. The expense of this method is not inconsiderable, and the delay necessarily incurred is often such as to prohibit its use on any work at all in a hurry. Perhaps the most satisfactory method of obtaining good castings practically available to the general consumer, is to specify the composition of the metal, and that the castings should be properly annealed and have a competent inspector see that the specifications are carried out.

The Hudson River Bridge.—The President has signed the New York and New Jersey Bridge bill, and the next step to be taken by the promoters of the enterprise is to submit the plans, which have already been drawn, for the approval of the Secretary of War. The company must complete the bridge within 10 years from its beginning, spending on its construction at least $250,000 the first year and $1,000,000 a year until its completion. The work will be begun, officers of the company say, as soon as Secretary Lamont approves the plans. The bridge will be a suspended cantilever bridge, and will cost, including approaches, in the neighborhood of $40 000,000. Its promoters say it probably will be completed in four years. At the center it will be 15 ft. higher than the Brooklyn Bridge. The bridge will be purely a railway bridge, with six tracks, for trains of all the railroad systems now terminating on the Jersey shore, including the Pennsylvania, Jersey Central, Erie, Lackawanna, West Shore, Ontario & Western, and others. It has been reckoned that 790 trains can pass over the bridge in a day. This project looks toward the erection of a union station on the west side to provide a terminus for all these railroads. According to the company's plans, it is proposed to take two city blocks, each 200 × 800 ft., and bounded by Forty-second, Forty-third, and Forty-seventh streets, by Seventh Avenue and Broadway and Eighth Avenue, giving an area of nearly four acres. On this will be erected two buildings, each 200 × 800 ft., connected by a footbridge over Forty-third Street. These will contain the usual waiting and other rooms and ticket offices, an arrival platform, and a departure platform, each of 20 tracks, a terminal hotel, a general receiving and distributing post office for the city, and a house for express and perishable freight; also 18 stores with their cellars, and about 180 business offices for the railway and for rental. The bridge over the Hudson River will be connected with the station at Broadway and Forty-second Street by a steel viaduct, the average height of which will be 60 ft., and the total length about 10,680 ft.

Canvas Cofferdams.—In a paper read before the American Society of Civil Engineers, Mr. M. Meigs, M. Am. Soc. C. E., described the use of canvas in making a cofferdam tight. The method was employed in repairing the locks of the United States Mississippi Canal at Keokuk, Ia., in 1893. Each leaf of the lock gates here was 27 ft. high by 46 ft. wide, and weighed 40 tons, and the leakage of the bottom 10 ft. was becoming serious, hence the need of repairs. The only available time of the year is at the commencement of the frosts in November, when the building of a cofferdam with gravel and timber would have been difficult. It was, therefore, determined to build the dam of timber and make it tight with canvas. A timber frame was accordingly built and towed into place, where its ends abutted on the flaring ashlar walls of the lock approach, while below it was a clear rock bottom. The framing was sunk by loading with old rails, and planks were then spiked on to it. For this purpose a "shot-gun" was used, which consisted of a ¾-in. pipe with an iron rod working on it. This pipe and rod extended above the surface, while below it was brought over the spikes to be driven by a diver. The rod was then struck by a hammer at the top. A canvas sheet was then spread over the face of the dam; 12-oz. duck was used, and a ¼-in. iron chain was sewn along the lower edge of the canvas to sink it into place. The canvas overlapped the bottom and wing walls by some inches. The work of placing the dam took about five days, after which the lock was pumped dry in about six hours. The leakage was insignificant, the head being 12 ft.

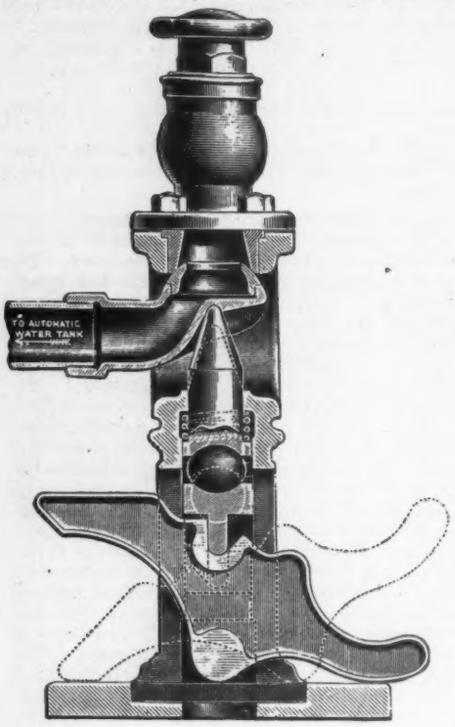


Fig. 1.

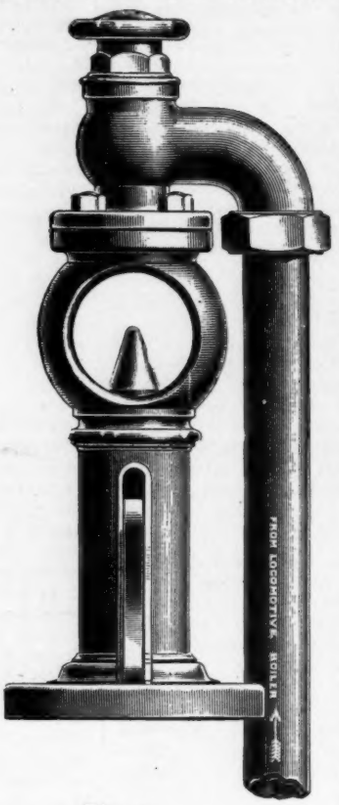


Fig. 2.

Chinese Railroads. — The first railroad in China was from Shanghai to Woosung, a distance of about 12 miles. Woosung is the bar at the mouth of the Whampoa River, and this road did a big business till some of the Chinese thought it was injuring their luck, and they complained to the authorities. The officials bought the road at a high price from the foreigners who owned it, and threw the locomotive, which they said contained a devil, into the river. Some of the rails are still left, and it may be that the road will be again built in the future. One thing is very certain, and that is the moment the Chinese appreciate that they can make and run roads of their own, their superstition will not stand in the way of making them, and many of the officials are experimenting to see what they can do. A locomotive has recently been built by the Chinese machinists at the Kiaguan arsenal, near Shanghai. Steel rails are also rolled, and the mill is very well managed.

There is a vast deal of waste now, it is true, and this will continue as long as the work is done by the officials, who expect to get a big living out of their stealings: but it will be different when factories of this kind are started as private enterprises. Just now the chief movements in the direction of railroads are from the government, and the idea is to render China impregnable in case of war. This is the purpose of the viceroy at Hankow. He hates the foreigners, and he wants to drive them out of the country. He is using them to build factories, and he has a cotton mill run by steam and filled with modern machinery, which is one of the largest in the world. It contains 1,000 looms, and it is located on the banks of the Yangtse, in the city of Wuchang. It is now making money, I am told, and it is profiting off the rise in foreign cottons through the fall in the value of silver.

Speaking of extravagance in railroad building, it is doubtful whether there has ever been erected a more costly plant than that which is now being put up here by this viceroy for the building of cars, the making of rails, and the turning out of a full equipment for the line which is at some future time to run to Peking. The works are being put up by Belgians as foremen, and about 50 high-priced men are now employed

here on salaries. They are located at the foot of a hill just above the mouth of the Han River and a short distance back from the Yangtse Kiang.

There is a railroad being built in the northern part of the empire, and the regular appropriation set aside for this has been $2,000,000 a year. This northern railway is the only working road in China. It has been pushed rapidly within the past year or so toward the Manchurian frontier, and was of service to the government in the recent rebellion there. It is for the purposes of defense that the Chinese will build railroads.

This northern road was first built to take coal from the mines to the Taku forts and the naval ships. Five years ago it was only about 80 miles long. It has now about reached the great wall, and will soon penetrate Mongolia.—*Halifax Herald.*

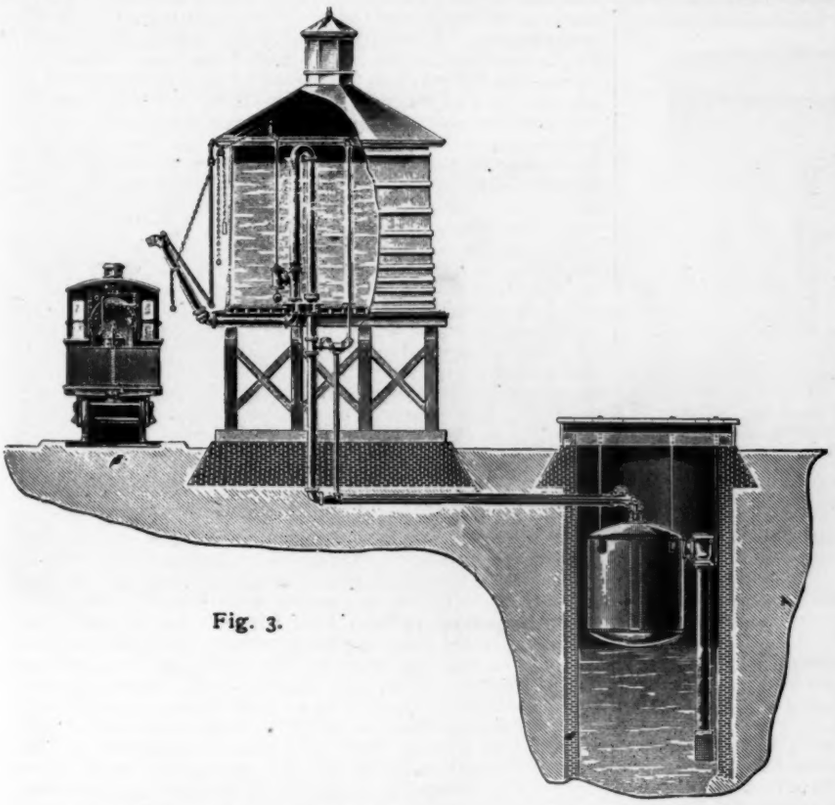


Fig. 3.

AUTOMATIC WATER-TANK.

THE Automatic Water-Tank Company, of 143 Liberty Street, New York, have placed an apparatus upon the market which is intended to do away with pumping stations for railroad service. The principal advantages claimed for the apparatus are that its first cost is no more than that of an ordinary pumping station, and, under some circumstances, will be even less, and that it does away entirely with all necessity for attendance, so that the wages of the men who attend these stations as well as the fuel consumed in the boilers used for generating steam to drive the pumps are saved.

The general system by which the apparatus works is that steam is taken from the boiler of the locomotive and carried to the top of a tank filled with water, pressing down upon the surface of the latter and forcing it up through a pipe leading from the bottom of this tank into the tender of the locomotive. The steam which then fills the tank is allowed to condense and thus forms a vacuum, causing the water to rise from the cistern to fill the tank and place the apparatus ready for use with the next engine.

At a recent exhibition of the apparatus that has been set up in Brooklyn, near the line of the Long Island Railroad, from the time the steam was turned into the tank until it was again filled was about two and one half minutes. Details of the apparatus have been very carefully worked out, and our engravings show the arrangements of the same. The side elevation and sectional view in figs. 1 and 2 show the connection which is made at the tender between the steam pipe leading to the automatic water-tank and the pipe from the engine. It will be seen that the pipe leading to the water-tank has a notch on the lower side of an elbow, the top surface of which is fitted into a ball joint at the bottom of the flange, over the top of which the steam enters from the boiler, as shown in the side elevation.

The treadle, which is shown in the release position in dotted lines, is arranged so that it has a cam motion passing the center with a stiff spring over the top which holds the tank pipe up into position and forms the steam pipe joint. The valve at the top of the elbow is then opened and steam admitted to the water tank. The water tank is located below the surface of the track, as shown in fig. 3. It is recommended by the company that there be an auxiliary water-tank above the surface, such as is now used, in order that, in case of failure or leakage or necessity of repairs to the lower tank, the upper one may serve as a storage reservoir from which engines may be filled until the automatic tank has been repaired. Steam enters the top of the automatic tank and presses the water down so that it forces up through the pipe which is shown in dotted lines, and which is turned in the syphon coming down to the spout leading to the engine. These underground tanks have a capacity equal to that of the tender to be filled. When the tender is full the steam is shut off, and an arrangement of check valves causes the water in the stand pipe between the tank and the spout to flow back and be sprayed into the top of the automatic tank rather than to enter it by the pipe from which it left. It thus forms a cooling spray which condenses the steam, producing a vacuum and causing the water to rise through the stand pipe leading down to the water in the cistern. This water then flows into the automatic tank, and always rises to a certain predetermined height.

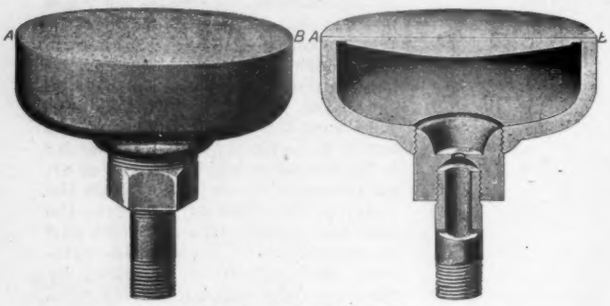
When the tank is made and first set up, steam is admitted in the ordinary way, and, of course, there being no water in the tank, it simply forces the air out through the stand pipes. After a time the steam will condense, and the tank be partially filled from the cistern. Then the second application of steam forces this water out, and its return through the stand pipe causes a complete condensation of the steam and filling of the tank.

The apparatus has been successfully used on one station of the Pennsylvania Road for some months, and an exhibition station, as we have already said, is now in operation in Brooklyn on the line of the Long Island Railroad.

BAKER'S SAFETY VENT.

IN the well-known Baker car heater the heat of the fire is conveyed or transmitted to the interior of the car by means of the circulation of water around the fire and through pipes laid near the floor of the car and extending through its whole length. In order to keep the water in the pipes warm they are arranged so that the fire will cause the water to circulate through them and around the fire continuously so long as the latter is kept going. During this process there is no loss of water unless it is caused by leakage. In order that the circulation should be maintained it is essential that the pipes should be completely filled with water. It is, therefore, important that there should not be any leakage of any kind, and that neither water nor steam should be allowed to escape from the heater under its normal condition. But, like a steam boiler, if the heater does not receive the attention it should have, it is liable to be overheated, and under such conditions an excessive pressure may be produced in the pipes, which, if it is not relieved, may produce an explosion. For this reason, and to guard against such contingencies, some means must be provided to relieve the excessive pressure in case of neglect by those who have the care of the apparatus. All ordinary safety valves consist of a number of parts, and are kept tight by some sort of steam joint, and are therefore liable to get out of order and to leak. As a safety valve is only needed in cases of emergency, and is not required in ordinary service of a car

heater, if it is at all complex it is liable not to be in good working condition when the emergency arises. Besides, any leakage, however slight, will in turn reduce the supply of water in the pipes, which will interfere with the circulation. For these reasons—that is, in order to provide a vent, in case of neglect of the heater and consequent overpressure in the pipes, which would have no liability to get out of order and would have no leakage whatever—Mr. William C. Baker, the well-known inventor of the car heater which bears his name, has designed what he calls a "jointless safety vent," which is shown by the engravings (figs. 1 and 2), the former being an external view and the latter a section. This is simply a cup-shaped casting with a pipe which is connected to the heater pipes screwed into the lower side, and a flat top, *A B*, which has a groove, *c c*, turned in the under side, so as to reduce the thickness of the metal forming the top around its circumference. The thickness of the metal over the groove is left just sufficient to resist the maximum pressure to which the pipes may



BAKER'S SAFETY VENT.

be safely subjected. When it exceeds this point the top is blown out, which, of course, relieved the pressure. The only damage which results is that the old "vent" is destroyed and must be removed and a new one screwed on in its place.

From the illustrations it will be seen that it is almost impossible for this device to get out of order and that no leakage can occur unless by the fracture of the top disk, or, as Mr. Baker expresses it, "there cannot be even a single drop of leak from it until the danger point is reached, when something must give way, and that something is the vent disk. No greater harm is involved in the bursting of the top of this vent than the small expense and the few minutes' time taken in screwing on another one, which may be done by hand."

The blowing off of the vent disk has also the advantage of being a record of the carelessness of the attendant, whereas any ordinary safety valve might blow off repeatedly and leave no sign of that fact after it was closed again.

This device was designed by Mr. Baker to be used in connection with his car heater, but it may be used for other purposes and on boilers of various types and kinds.

The address of the inventor and manufacturer is 143 Liberty Street, N. Y.

THE LESLIE PATENT LOCOMOTIVE FIRE KINDLER FOR KINDLING LOCOMOTIVE FIRES WITH CRUDE OIL INSTEAD OF WOOD.

THE apparatus which the inventor of this appliance has devised for the purpose of kindling the fires in locomotives with crude oil instead of wood consists of a suitable storage tank in connection with the engine house or other locality where fires must be kindled, and capable of holding the requisite quantity of oil for the service for which it is intended. A small tank or auxiliary reservoir, which is fed from the storage tank, is also provided, and suitable globe and check valves are located between the two tanks, the former being intended to shut off the whole supply from the storage tank if necessary, and the latter to feed the required quantity of oil to the auxiliary reservoir.

An ordinary air pump, which supplies air to a storage reservoir at a pressure of 60 or 70 lbs. for shop purposes, can be utilized to supply sufficient air for the kindler through a pipe connected with said storage reservoir and entering a locker suitably located in the round house. In this locker an air pressure regulator reduces the pressure to about 20 lbs., and the main air pressure pipe extends from there round the house over each stall; a smaller air service pipe enters the auxiliary reservoir, and passing through the locker, extends, in close proximity to the main air pressure pipe, round the house, and is connected with the latter by suitable branch pipes and the intermediary of a lock combination valve over each stall. An oil service pipe emerges from the auxiliary reservoir, and passing also through the locker, follows the same course as the two former pipes, a branch pipe being connected to the same and also to the lock combination valve above the stalls—the latter is so located as to be conveniently unlocked and opened from the engine. The whole supply of air and oil to these pipes is controlled by suitable valves placed in the locker before mentioned, in which also are located the gauges, all being placed under lock and key; in this way the absolute control of the whole system is in the charge of one person; and when the system is opened to service the control of the supply to each stall is governed by its respective lock combination or regulating valve.

When a fire is to be kindled, sufficient coal is thrown into the fire-box to cover the grate thoroughly; a light and easily handled burner, with two small hose attached for air and oil, is connected by suitable hose couplings to the lock combination valve; after the burner has been connected by unlocking and opening the combination valve, the oil is brought into the house automatically and the air and oil simultaneously admitted to the burner. A small piece of greasy waste is then lighted and thrown into the fire-box on top of the coal; the air and oil are then turned on to the burner by their respective valves, the necessary quantity of oil only being fed automatically, making it impossible to injure the fire-box sheets either through carelessness or otherwise. When the fire has been kindled by the closing of the lock combination valve, the supply of air and oil is shut off simultaneously and the oil remaining in the pipe is automatically returned to the auxiliary tank, after which the burner is disconnected.

The storage and auxiliary tanks are buried in the ground outside of the buildings and below the frost line, fully protecting the oil not only from fire, but also from all kinds of weather, and at the same time economizing space. The location of the pipes over the stalls, where they are entirely out of the way, the means of controlling the whole system by having the controlling valves, including those which are placed out of reach over the stalls, securely locked, so that persons passing through the round house cannot interfere or tamper with them, even the safety and accuracy in kindling fires with this device are not dependent upon the operator, but are due to the fact that those parts which have to be manipulated by him are so arranged that they are either automatically adjusted or it is compulsory for him to adjust them properly to enable him to do the work, in this way protecting the property from all risks through carelessness or otherwise.

The success of this device, it is claimed, has been fully established by actual use in kindling many thousands of fires on several important railroad lines where it has been adopted, and has attracted much attention on account of its cheapness, convenience and the great saving which has been effected through its use. It has been shown that to kindle a fire only 1½ galls. of oil is required to do what takes one-eighth of a cord of wood, and that as much or more steam will be generated by the oil as by the wood. One car-load of oil, = 6,000 galls., will kindle as many fires as 71 car-loads of wood, = 500 cords. The difference in the cost of transporting, handling, sawing and storing the wood and oil is saved by the use of the latter. Less space is occupied by the appliances and the material for kindling with oil than is needed for the wood. Oil is always equally efficient at all times, whereas wood, if it is green or wet, will not kindle readily. In cases of emergency illuminating or lubricating oil may be used. Wood is more liable to be stolen, there is more risk of fire when it is used, and as a larger number of cars are required to transport it, the danger of wreckage is greater. Kindling fires with oil is therefore cheaper, the appliances are simpler, more convenient, cleaner; much time is saved in kindling fires and getting up steam, no wood sparks, which are very liable to start fires, are thrown from the chimney, the annoyance and delay connected with the supply of wood is avoided.

Tests made on the Chicago, Rock Island & Pacific Railroad in kindling fires with one-eighth of a cord of wood and 1½ galls. of oil showed that there was a very material saving of time in kindling the fire and getting up steam with oil compared with wood. The cost of one-eighth of a cord of wood is 33⅓ cents, while 1½ galls. of oil at 1.71 cents per gallon costs only 2 56½ cents, so that the saving is apparent. The average quantity of oil used to kindle over a thousand fires was only 1.31 galls., and the cost 2.24 cents. In the month of May the average cost on the Burlington, Cedar Rapids & Northern Railroad was just 3 cents. In June it was 1.72 cents. With a little experience with the apparatus the amount of oil consumed to kindle each fire was reduced to less than 3 quarts and the cost was reduced to about 1⅛ cents. This apparatus is destined to work a revolution in the method of kindling fires in locomotives, and will largely reduce the cost, the time consumed, and add to the convenience of starting fires and getting up steam.

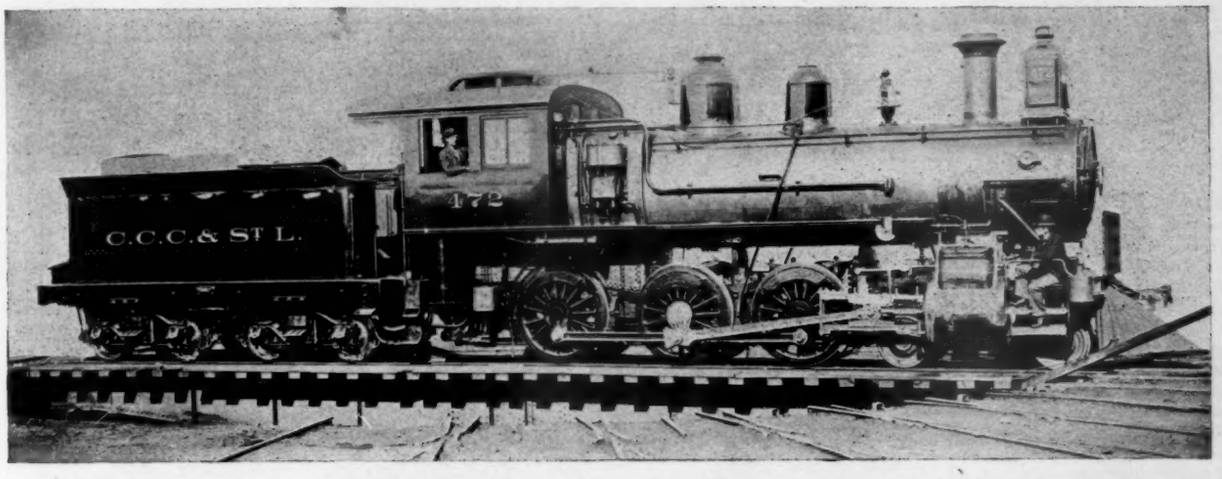
The various patents on this device are owned by Mr. J. S. Leslie, of Paterson, N. J.

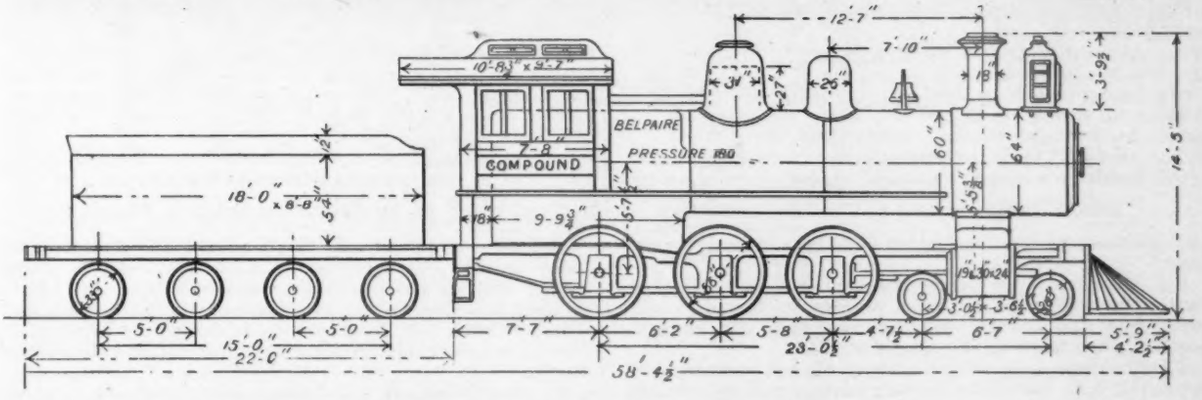
RICHMOND COMPOUND LOCOMOTIVE.

SOME time ago the Richmond Locomotive Works built a compound consolidation locomotive for the Cleveland, Cincinnati, Chicago & St. Louis Railway, using an intercepting valve designed by Mr. C. J. Mellin, Chief Draftsman of the establishment. The engine has now been working for several months on the road and is giving very good satisfaction, as the relative coal saving effected in its performances as compared with the other engines reported in our April issue would indicate. The engravings of the side elevation in outline and the reproduction of the photograph give a very clear idea of the appearance and construction of the engine, and the following are among its principal dimensions :

Kind of fuel used	Bituminous coal.
Gauge of road	4′ 8½″
Total weight of locomotive in working order, including two men, from scale with two gauges of water	141,400 lbs.
Total weight on driving-wheels (about)	112,000 "
" wheel base	23′ 1½″
Distance between center of front and back driving-wheels	11′ 10″

Inside lap of L.P. slide valve	1″
" " " H.P. " "	⅛″ and ¼″
Outside lap of L.P. slide valve	¾″
" " " H.P. " "	¾″
Lead of slide valves L.P. in full stroke	½″
" " " " H.P. " "	⅛″
Diameter of driving-wheels outside of tires	60″
" " front truck-wheels	28″
" " back truck-wheels	28″
Size of main driving-axle journal, diameter and length	8″ × 9½″
" " other " " "	8″ × 9½″
" " truck axle journals, diameter and length	5¾″ × 10″
" " main crank-pin journals, diameter and length, internal	6″ × 5″
Size of main crank pin journals, diameter and length, outer	5½″ × 6½″
" " coupling-rod journals, diameter and length	4″ × 4″
Length of driving-springs, measured from center to center of hangers	36″
Description of boiler	Belpaire.
Inside diameter of smallest boiler ring	60″
Material of barrel of boiler	Steel.
Thickness of plates in barrel of boiler	⅞″
Kind of horizontal seams	Double-riveted butt seams.
" " circumferential seams	Double-riveted lap seams.
Material of tubes	Lap-welded iron.
Number of tubes	241





COMPOUND LOCOMOTIVE, BUILT BY THE RICHMOND LOCOMOTIVE WORKS.

Distance from center of main driving-wheels to center of cylinders	13′ 4″
Distance from center of main driving-wheels to center of back driving-wheels	6′ 2″
Length of main connecting-rod from center to center of journals	9′ 1″
Transverse distance from the center of one cylinder to the center of the other	7′ 4″
Diameter of L.P. cylinder and stroke of piston	30″ × 24″
" " H.P. " " " "	19″ × 24″
Horizontal thickness of piston over piston-head and follower plate	6″
Kind of piston packing, H.P.	Dunbar.
" " " L.P.	Simple rings.
Diameter of L.P. piston-rod	3½″
" " H.P. "	3½″
Size of steam L.P. port	23″ × 1⅞″
" " " H.P. "	23″ × 1¼″
" " exhaust L.P. "	23″ × 3¼″
" " " H.P. "	23″ × 2½″
Greatest travel of L.P. slide valve	5¾″
" " " H.P. " "	5½″

Diameter of tubes, outside	2″
Distance between center of tubes	2¾″
Length of tubes over tube plates	13′ 10½″
" " fire-box	8′ 11½″
Width " "	3′ 5¾″
Depth " "	5′ 1¾″ to 5′ 7⅜″
Water space, side of fire-box	3½″
" " back of fire-box	4″
" " front of fire-box	4″
Material of outside shell of fire-box	Carnegie steel.
Thickness of plates of outside shell of fire-box	½″
Material of inside fire-box	Carnegie steel.
Thickness of plates inside	⅜″
" " " back end of fire-box	⅜″
" " crown-plate	⅜″
Material of tube-plates	Carnegie steel.
Thickness of front tube-plates	½″
" " back tube-plates	½″
How crown-plate is stayed	Vertical and horizontal stays.
Diameter of dome	31″
Maximum working pressure per sq. in.	270

Kind of grate	Racking finger.
Width of opening between bars (or tubes) about	1 in. between fingers.
Grate surface	31.3 sq. ft.
Heating surface in fire-box	172 "
" " of the outside of tubes	1,756 "
Total heating surface	1,928 "
Kind of blast nozzle	Single.
Diameter of blast nozzle	5½"
Smallest inside diameter of chimney	15"
Height from top of rails to top of chimney	14' 5"
" " " " " " center of boiler	7' 11½"
Weight of tender empty	41,650 lbs.
Number of wheels under tender	8
Diameter of tender-wheels	33"
Size of journals of tender axles, diameter and length	4½" × 7¼"
Total wheel-base of tender	15' 0"
Distance from center to center of truck wheels of tender	5' 0"
Water capacity of tank (in gallons of 231 cu. in.)	4,000 galls.
Total wheel-base of engine and tender	49' 1½"
" length of engine and tender over all	58' 4¾"
Throw of eccentrics	5½"

The intercepting valve, as we have already said, was designed by Mr. Mellin, and its construction is very clearly shown by the engravings which we present, in which the various positions which it occupies while in service are represented.

Fig. 1 shows the position starting automatically ; fig. 2 the starting position at the maximum pressure in the low-pressure steam-chest ; fig. 3 when working compound, and fig. 4 the position when working as a simple engine.

The drawings show sections through the low-pressure cylinder saddle with the valves in their various relative positions. The high-pressure cylinder exhausts into the receiver, which is placed inside the smoke-box and opens into the chamber *F*. The intercepting valve, as shown at *V* in the several views, has a piston on its forward end which acts in its cylinder as an air dash-pot, to prevent any slamming of the valve. Around the stem of this valve is a sleeve, *L*, which has an axial movement on the stem, and acts as an admission and reducing valve to the low-pressure cylinder when starting and when working simple. Valve *H* is a plain winged valve with a piston on its rear end, and is called the emergency valve, as by its use the engineer can at will operate as a simple engine. When starting, steam from the boiler goes to the high-pressure cylinder in the ordinary way, and also to the port *C* through a 2-in. steam pipe connected to the dry pipe. There is then no pressure in the receiver *F*, and the pressure on the shoulder *E* of the sleeve *L* (fig. 2) moves the sleeve and valve *V* to the right, closing the receiver and letting steam past the shoulder *E* into the low-pressure valve chest *G*.

Now, since the area of the end *B* of the sleeve *L* is, say, twice that of the shoulder *E*, half of the boiler pressure will move the sleeve *L* to the left, cutting off steam from port *C*, and thus equalizing the work in both cylinders. After, say, one and a half revolutions, the pressure accumulates in the receiver *F* and moves the valve *V* to the left, carrying the sleeve with it ; when, the steam being permanently cut off at *C*, there is a straight connection between the two cylinders. In starting on grades, or when exerting maximum power, the engineer can move the three-way cock in the cab, letting boiler steam behind the piston on the emergency valve *H* and holding it open against its spring. This exhausts the small cavity *J* in which the pressure is equalized with the receiver through holes in the valve *V*, and then the valves *V* and *L* move instantly to the right, assisted by steam pressure on the shoulder *E*. The high-pressure cylinder has now a separate exhaust, and the low-pressure cylinder gets its steam direct from the boiler through the port *A* and reducing valve *L*. Except when working simple the valves act entirely automatically. The lubricator to the low-pressure cylinder enters port *A*, and thus insures constant lubrication to the intercepting and reducing valves.

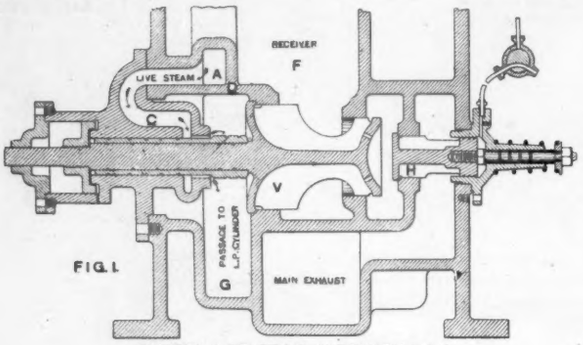


FIG. 1.

POSITION IN STARTING AUTOMATICALLY

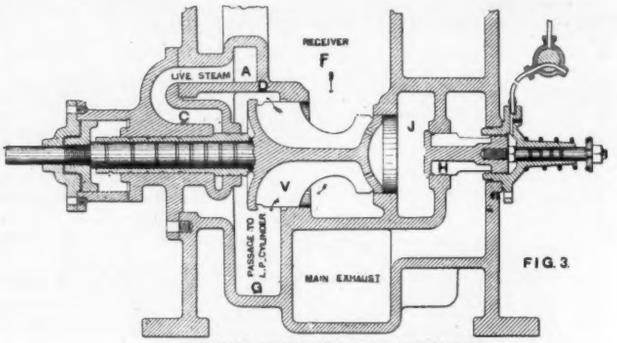


FIG. 3.

POSITION WHEN WORKING COMPOUND

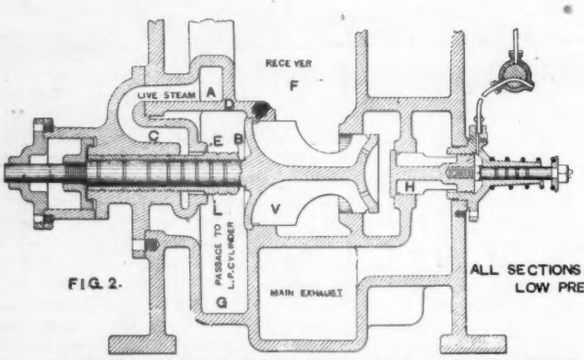


FIG. 2.

POSITION IN STARTING AT MAXIMUM PRESSURE IN L.P. STEAM CHEST

ALL SECTIONS THROUGH SADDLE OF LOW PRESSURE CYLINDER

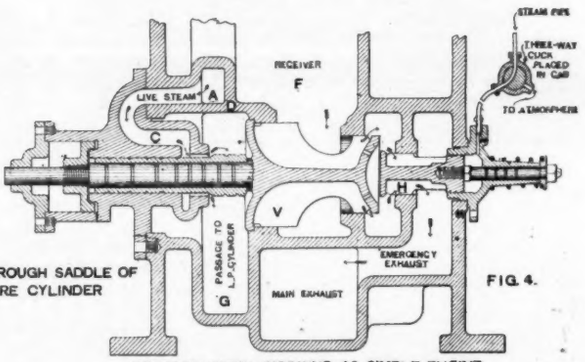


FIG. 4.

POSITION WHEN WORKING AS SIMPLE ENGINE

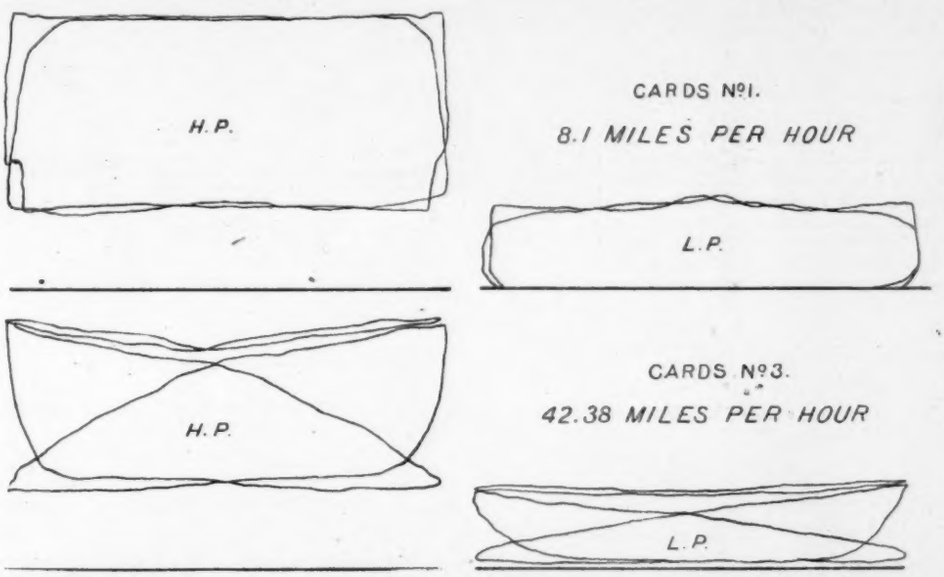
MELLIN INTERCEPTING VALVE FOR COMPOUND LOCOMOTIVE, BUILT BY RICHMOND LOCOMOTIVE WORKS.

Owing to the small area of port *C* and the contracted exhaust through *H*, the engine develops less power as a simple engine than as a compound at a speed of over, say, 5 miles an hour, and thus the runner is compelled to work compound.

Should *either* side break down, the emergency valve can be opened and the engine brought in on one side like an ordinary engine.

To recapitulate : It will be seen, then, that in fig. 1, where the engine is simply started by opening the throttle, steam enters the low-pressure cylinder from the dry pipe through the 2-in pipe *A*, the passage *B*, and passes by the opening made by the sleeve *L* into the steam passage to the low-pressure cylinder. Meanwhile, the high-pressure cylinder is exhausting into the receiver and raising the pressure there and in the chamber *J*. As soon as the pressure in the low-pressure steam-chest is one-half of that in the dry pipe, the pressure against the sleeve *L* at *B* pushes it back into the position shown in fig. 2. This, of course, is only temporary, because the moment steam is admitted again into the low-pressure cylinder pressure is reduced in the chamber *G* and the sleeve moves back to its position of fig. 1. As soon, however, as the receiver pressure and that in the chamber *G* rises so as to be slightly in excess of that in the passage to the low-pressure cylinder *G*, the whole intercepting valve is thrown back into the position of fig. 3, and at that point live steam, entering at *A*, is cut off by the sleeve *L* and the exhaust steam passes direct from the high-pressure cylinder through the receiver into the low-pressure steam-chest, as shown in fig. 3.

When the engine is to be worked as a simple engine, as has already been said, the valve is moved into the position of fig. 4; steam then enters at *A*, passes through *C* around the opening at *L* into the low-pressure cylinder. The exhaust from the high pressure cylinder passes through the receiver around the dash pot piston of the main valve through the chamber *J*, passes the valve *H* and out into the main exhaust by way of the emergency exhaust, as marked. The action of the engine is very clearly shown by the two sets of indicator cards which we publish. One of them is taken at the speed of 8.1 miles per hour, and the other at 42.38 miles per hour. In the first the lever was down in the corner, the steam pressure 170 lbs., the engine making 50 revolutions per minute. The mean effective pressure in the high-pressure cylinder is found to be 114 lbs.; in the low-pressure cylinder it is 48 lbs. The H.P. developed was 196 in the high-pressure and 205 in the low-pressure cylinder, making a total of 401, thus showing that the equalization of work done by the two cylinders is practically perfect, the actual variation being less than 5 per cent.



INDICATOR CARDS FROM COMPOUND LOCOMOTIVE, BUILT BY THE RICHMOND LOCOMOTIVE WORKS.

In the other cards where the speed was higher the boiler pressure was 155 lbs., the cut-off was at 15 in., and the engine was making 260 revolutions per minute, with a mean effective pressure in the high-pressure cylinder of 64 lbs. and 26 lbs. in the low pressure, developing a H.P. of 572 and 578 lbs. in the high and low-pressure cylinders respectively, making a total of 1,150 H.P. The variation here, it will be seen, was only 6 H.P., which amounts to a trifle over 1 per cent. It is interesting to note the saving of fuel reported in connection with the performances of this locomotive, which runs from 30 to 35 per cent., according to the published reports. The details of the tests by which this saving has been effected are not at hand, and it is therefore impossible for us to make an analysis of them to determine whether the whole or only a part of the actual saving was due to the compound principle.

SOME ENGINES OF THE GERMAN RAILWAY UNION.

THE last supplement of the *Organ*, which appeared in 1893, contained a description of a number of types of locomotives, passenger and freight cars which have been put into service during recent years on the different lines of the German Railway Union. We select from this work, which contains a large number of interesting reports, a description of three express engines, two of which differ from types which are in general use.

Express Locomotive for the Bavarian State Railways.—These locomotives, fig 1, were built by Mafei, of Munich, in 1891, for four wheels coupled at the back with a bogie truck in front. The cylinders and steam-chests are outside the frames, and the distance from center to center is 6 ft. 8 in. The boiler is of iron and the fire-box of copper. The shell is formed of three sheets with an average diameter of 4 ft. 7 in. and a thickness of .6 in. The transverse and longitudinal seams are double riveted, which was done with a Tweddell hydraulic riveter. The iron sheets used in the construction of the boiler have a tensile strength of 51,260 lbs. per square inch, with a minimum elongation of 18 per cent. At a service pressure of 180 lbs. per square inch these sheets are subjected to a strain of 7,100 lbs. in the full and 9,700 lbs. at the riveted joints.

The thickness of the tube sheets is 1 in., and while the crown sheets is $\frac{7}{8}$ in. and the side sheets $\frac{5}{8}$ in., the outside shell of the fire-box is .7 in. thick, and is connected to the crown-sheet by stay-bolts riveted to the outside and provided with nuts under the crown sheet; the two rows of stay-bolts alongside of the tube-sheet are so arranged as to permit a free expansion. The tubes are of iron, and the fire-box is provided with an arch as well as a deflector above the door, which is furnished with openings allowing air to be admitted into the fire-box. The grate is divided into three parts, and is inclined toward the front end. Two safety-valves 4.33 in. in diameter are located over the fire-box. The dry-pipe is in a dome placed on the second sheet of the shell, and the throttle-valve is a double valve. The smoke-box is provided with a spark-arrester and has a length of 3 ft. 11$\frac{1}{4}$ in., and is provided with Adams's vortex blast-pipe. The frames are composed of four sheets of steel 1 in. thick rigidly stayed together by means of transverse plates. The spacing of the sheets of the frame is less at the front end than at the back, the difference being 2$\frac{1}{4}$ in., thus permitting a lateral movement of the bogie; this latter is arranged as in the engines of the South-eastern Railway of England. The boiler rests on two coupled axles at the back by means of two lateral equalizing levers outside the frames. The Walschaert valve-motion is used. The locomotive is provided with the necessary apparatus for heating cars with steam; a Petri steam indicator placed over the running board near the engineer. Nathan oilers are used for lubricating the cylinders and valves. The tender has three axles and carries 27,120 lbs. of water and 6 tons of coal. In addition to the Westinghouse brake it is also provided with the Exeter brake. The tender wheels have a diameter of 3 ft. 2$\frac{1}{4}$ in. The brake-shoes work on each side of the six wheels. The weight of the tender empty is 13 tons, and in service it is 32 tons. The total wheel-base is 10 ft. 10 in. The principal dimensions of the engine are as follows:

Diameter of cylinders	1′ 5″
Stroke of pistons	2′ 0″
Diameter of driving-wheels	6′ 1″
" " truck wheels	3′ 3¼″
Center to center of truck-wheels	7′ 2½″
" " " " driving-wheels	8′ 4⅛″
Total wheel base of engine	21′ 10⅝″
Outside diameter of tubes	1¾″
Inside " " "	1⅝″
Length of tubes	12′ 9½″
Number "	218
Heating surface in tubes	1,508½ sq. ft.
" " " fire-box	106½ "
Total heating surface	1.415 "
Grate area	23.68 "
Boiler pressure	180 lbs. per sq. in.
Weight in working order on front axle	23,152 lbs.
" " " " " second axle	24,650 "
" " " " " third "	30,870 "
" " " " " fourth "	30,870 "
Total weight	108,542 "
" " on drivers	61,740 "

Express Locomotive with Lentz Boiler, for the Left Bank Railways of the Rhine.—This locomotive, fig. 2, was built in 1892 by the Hohenzollern Works, at Düsseldorf. It has four wheels coupled at the back with a bogie in front. There are outside cylinders placed horizontally in the transverse center line of the bogie. Outside valve gearing of the Joy system is used.

The frames are formed of two plates 1 in. thick stayed together by transverse plates, and along the whole length of the frames by a horizontal sheet riveted along the center of the main frame pieces.

The boiler rests at the front end upon a bogie like that used upon the Italian express locomotives of the Mediterranean Railway. The pivot and the piston which rests upon it are of cast steel; spiral springs are used placed on outside of the bogie, and which resist a forward motion of the engine, yet the inclined equalizers permitting a lateral movement of the bogie. These equalizers are arranged so as to take up the movement and lateral pressure which result when there is no play between the rail and the flange of the wheel.

On roads of	Lateral movement.	Lateral pressure.
3,280 ft.	⅝ in.	103 lbs.
984 "	1 ft.	2,778 "
590 "	1 ft. 8 in.	4,432 "

The boiler is formed of three sheets .7 in. thick. The center one is cylindrical with a diameter of 5 ft. 4⅛ in. The front and back ones are conical, with a diameter at the extreme ends of 4 ft. 1 in. and 4 ft. 1⅛ in.; the back is, furthermore, inclined to the center line of the boiler. There are no longitudinal seams, the sheets being welded. The smoke-box is fastened to the frame, and the boiler rests at the back end upon two lateral bars fastened to the frames. A pivot placed in the center below the fire-box resists all movement of the boiler. The corrugated fire-box, which occupies the back sheet and the greater part of that in front of it, has an inside diameter of 3 ft. 7½ in. and an outside diameter of 3 ft. 11½ in. The grate is horizontal and in two parts; its length is 6 ft. 10 in. It rests at the front end upon a stay of cast iron surrounded by fire-brick, and in front of this stay is the combustion chamber where the gases are burned. The fire-box tube-sheet carries the whole strain of the expansion of the fire-box and the tubes; it is only ½ in. thick. The tender carries 3,960 galls. of water and 5 tons of coal.

The principal dimensions of the engine are as follows:

Diameter of cylinders	1′ 5″
Stroke of pistons	2′ 0″
Diameter of driving-wheels	6′ 5⅛″
" " truck-wheels	3′ 2⅝″
Center to center of truck-wheels	6′ 6¾″
" " " " driving-wheels	7′ 10½″
Total wheel base	21′ 5⅞″
Outside diameter of tubes	1.8″
Inside " " "	1.6″
Length of tubes	9′ 6″
Number "	241
Heating surface of tubes	1,003 sq. ft.
" " " fire-box	119 "
Total heating surface	1,122 "
Grate area	21½ "
Boiler pressure	210 lbs. per sq. in.
Weight in working order, front axle	23,700 lbs.
" " " " second axle	23,700 "
" " " " third axle	33,070 "
" " " " fourth "	33,070 "
Total weight	113,540 "
" " on drivers	66,140 "
Weight when empty	100,212 "

Express Locomotive for the Würtemberg State Railways.—This locomotive, built by the Société Cockerill, of Seraing, in 1892, is intended to haul trains weighing 150 tons up continuous grades of 10 per cent. at a speed of 37 miles per hour.

The frames are inside and the engine rests upon the two coupled driving-axles, which are placed between two carrying-axles, one of which is at the front and the other at the back beneath the fire-box. These two latter axles are radial, so that the engines can run over curves of 490 ft. radius. Fig. 3 shows the arrangement which permits this radial axle; a connecting-rod *a* is attached to each axle at the points *b* and *c* by vertical levers *d g* and *e f*, which turn about the fixed points *d* and *e*; one rod, *f g*, is fastened to the back end of each of these back levers, and when one of the axles becomes radial its conjugate takes the same position. The same arrangement exists on each side of the engine. The connection *g f* is prolonged to *o*, where it is fastened to the lever *o p m*; this lever is fastened at *m* to a horizontal equalizing lever *m l n*, which turns about the fixed point *l* while its end is fastened to the tender. It thus assumes an oblique position relatively to the locomotive; the equalizing lever turns about the point *l*, and in consequence of the position taken by the points *m m*, the axles assume a radial position.

The boiler is of mild steel, having the maximum resistance of 64,000 lbs. per square inch and a minimum resistance of 54,000 lbs. per square inch, with an elongation of 25 per cent., and has been calculated for a working pressure of 225 lbs. per square inch; it has been tested, to 255 lbs., but in regular service the pressure is only 180 lbs. The crown-sheet is strengthened with stay-bolts. The boiler is prolonged at the front end by a smoke-box having a length of 6 ft. The engine has three cylinders of the same diameter, which can be made to work either compound or in the ordinary way. For this purpose a steam-chest receiving the steam directly from the boiler is placed above the center cylinder. According to the position occupied by a valve placed in this box, the steam from the boiler enters the second cylinder, and thence through an intermediate receiver it passes into the side cylinders, where it expands and finally escapes through the exhaust. By reversing the position of the valve in this distributing chest the steam from the boiler enters the intermediate receiver directly, and thence passes into each of the lateral cylinders and also into the center cylinder, whence it escapes into the atmosphere; the locomotive is then working as a non-compound. For the sake of obtaining an equal amount of work in the side cylinders while working compound, a valve which prevents the pressure in the outside cylinders from exceeding half of that of the center cylinder is used. The side cylinders are outside and are provided with Allen valves; the center cylinder has a Walschaert valve gear; the three cylinders drive the same axle, which is the forward driving-axle. The following are the principal dimensions:

Diameter of cylinders	1′ 4⅛″
Stroke of pistons	1′ 10″
Diameter of driving-wheels	5′ 5″
" " truck wheels	3′ 5″
Distance from center to center of driving-wheels	7′
Total wheel base	19′
Outside diameter of tubes	1¾″
Inside " " "	1⅝″
Length of tubes	14′ 1″
Number "	250
Heating surface in tubes	1,490 sq. ft.
" " fire-box	103 "
Total heating surface	1 593 "
Grate area	21½ "
Boiler pressure	180 lbs. per sq. in.
Weight in working order, front axle	28,670 lbs.
" " " " second axle	30,434 "
" " " " third axle	30,434 "
" " " " fourth axle	29,993 "
Total weight	119,530 lbs.
Weight on drivers	90,840 "
" empty	105,217 "

TRANSPORTATION OF A TORPEDO BOAT FROM TOULON TO CHERBOURG.

By M. Partiot.

The possibility of effecting a passage of a torpedo boat over the railways having been determined, I thought that it would be well to inform the quartermaster at the Navy Department to that effect, so that if he wished to avail himself of this method of transportation, I could put myself at his disposal in order to make the test. Admiral Aube, who was at that time Minister, directed the quartermaster to instruct me to carry out this affair, and examine into the transportation of a torpedo boat having a length of 108 ft. 3 in. from Cherbourg to Toulon. I then transmitted officially the schedule of my first investigations to the Minister of Public Works, who transmitted them to his colleague. I forwarded one to the directors of the Paris, Lyons & Mediterranean Company and to their staff, and received from them their assurances of the utmost assistance in the difficult task which I had undertaken in the interest of national defense. There still remained, however, some questions to solve, and they gave rise to long and careful examinations.

The Navy Department had first to make an examination to see whether, when a torpedo boat was set upon two trucks, with its ends overhanging 36 ft. 5 in. from the cradles, the sheets would not be too thin to sustain it in this position, as well as to withstand the shocks of transportation without being deformed, and especially without cracking. This examination was made by the naval engineers, who decided that the sheets would only have to carry, with this method of loading, a strain which was very much less than their tensile strength. Nevertheless, experience was the only thing that could determine definitely regarding the dangers of oscillations which might occur *en route*. It then became necessary to choose a convenient route. This was done by the railway companies. They preferably chose single-track roads, because the passage could then be made without any passings, and the breadth of the load was not limited by half the breadth and the narrow distance between the rails.

Furthermore, the maintenance of the track sometimes requires the ties to be raised when the normal height of the rails is not the same as that indicated by the maps in the neighborhood of permanent structures, and the clear space between the structures and the outside rail might possibly have been diminished. Finally, on curves, the track tends to be dis-

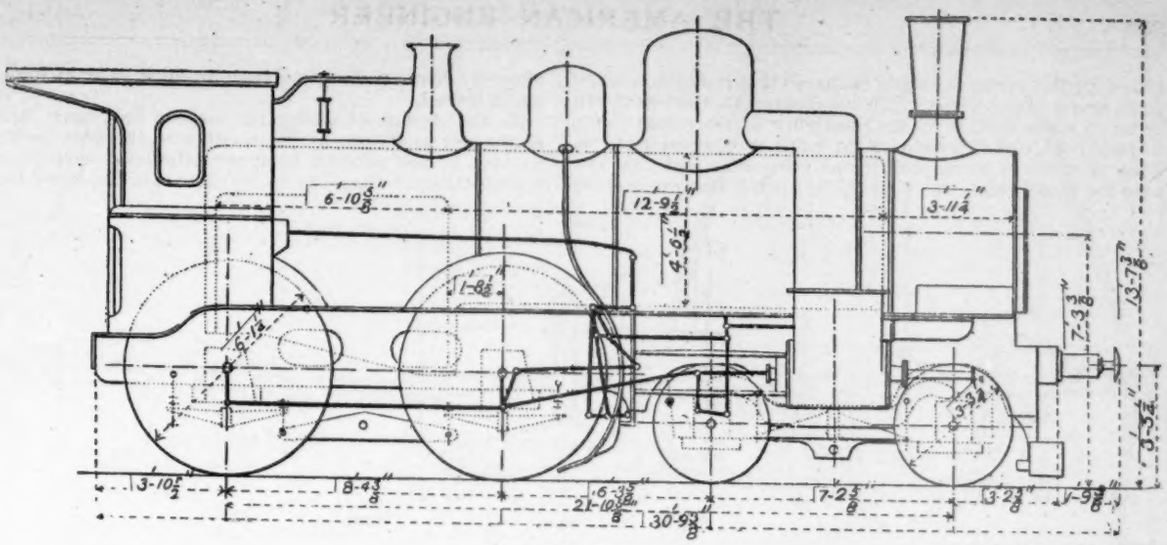


Fig. 1.

EXPRESS LOCOMOTIVE FOR THE BAVARIAN STATE RAILWAYS.

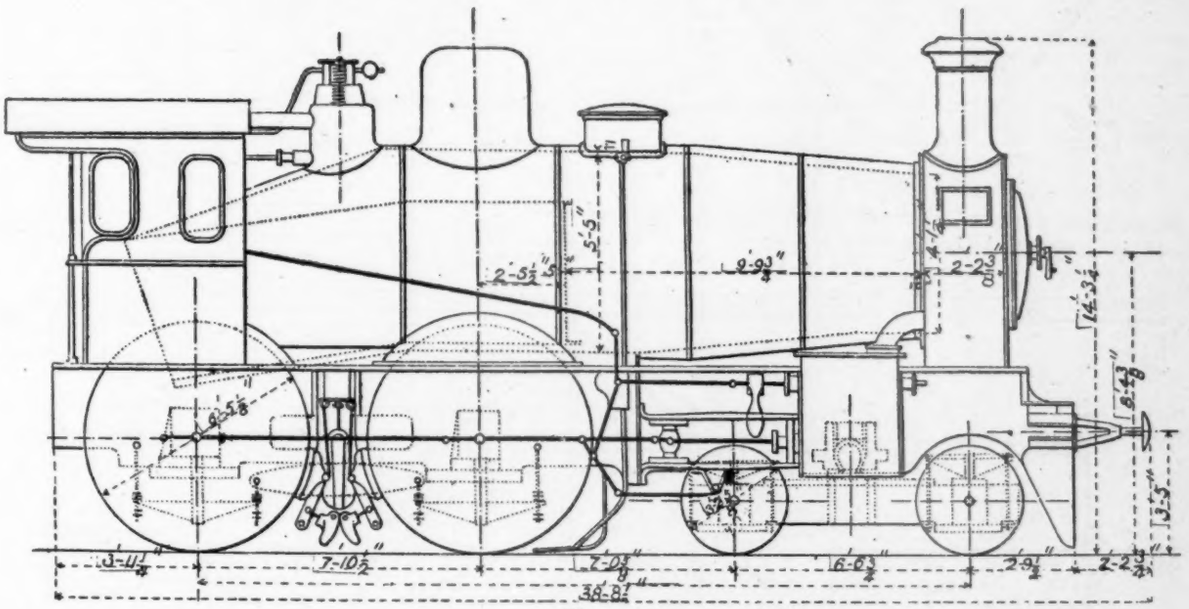
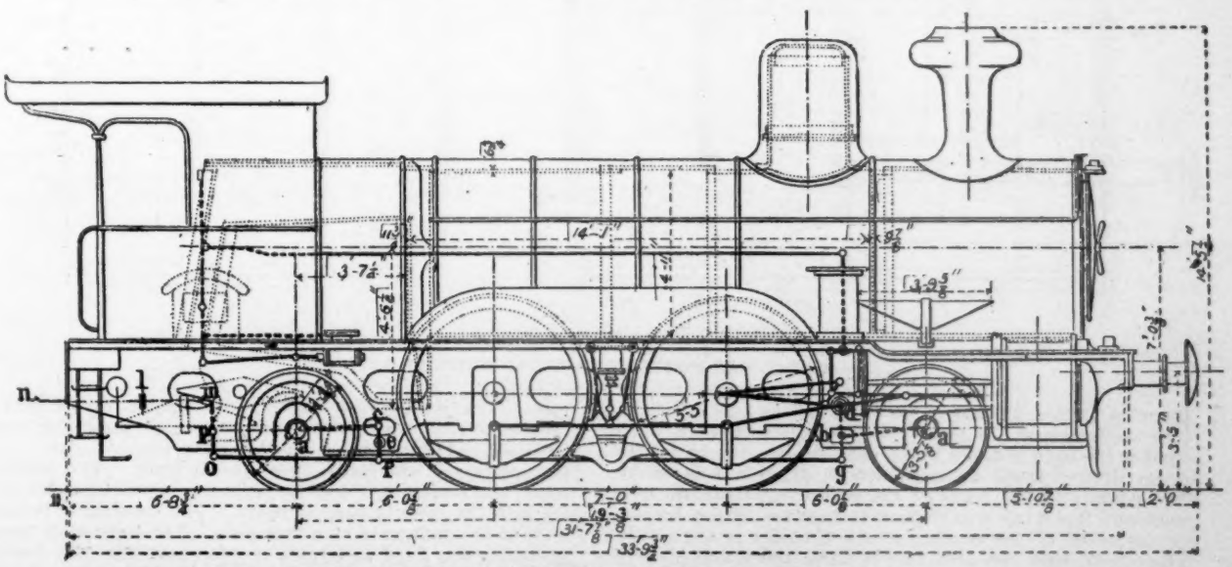


Fig. 2.

EXPRESS LOCOMOTIVE WITH THE LENTZ STAYLESS BOILER, FOR THE RAILWAYS ON THE LEFT BANK OF THE RHINE.

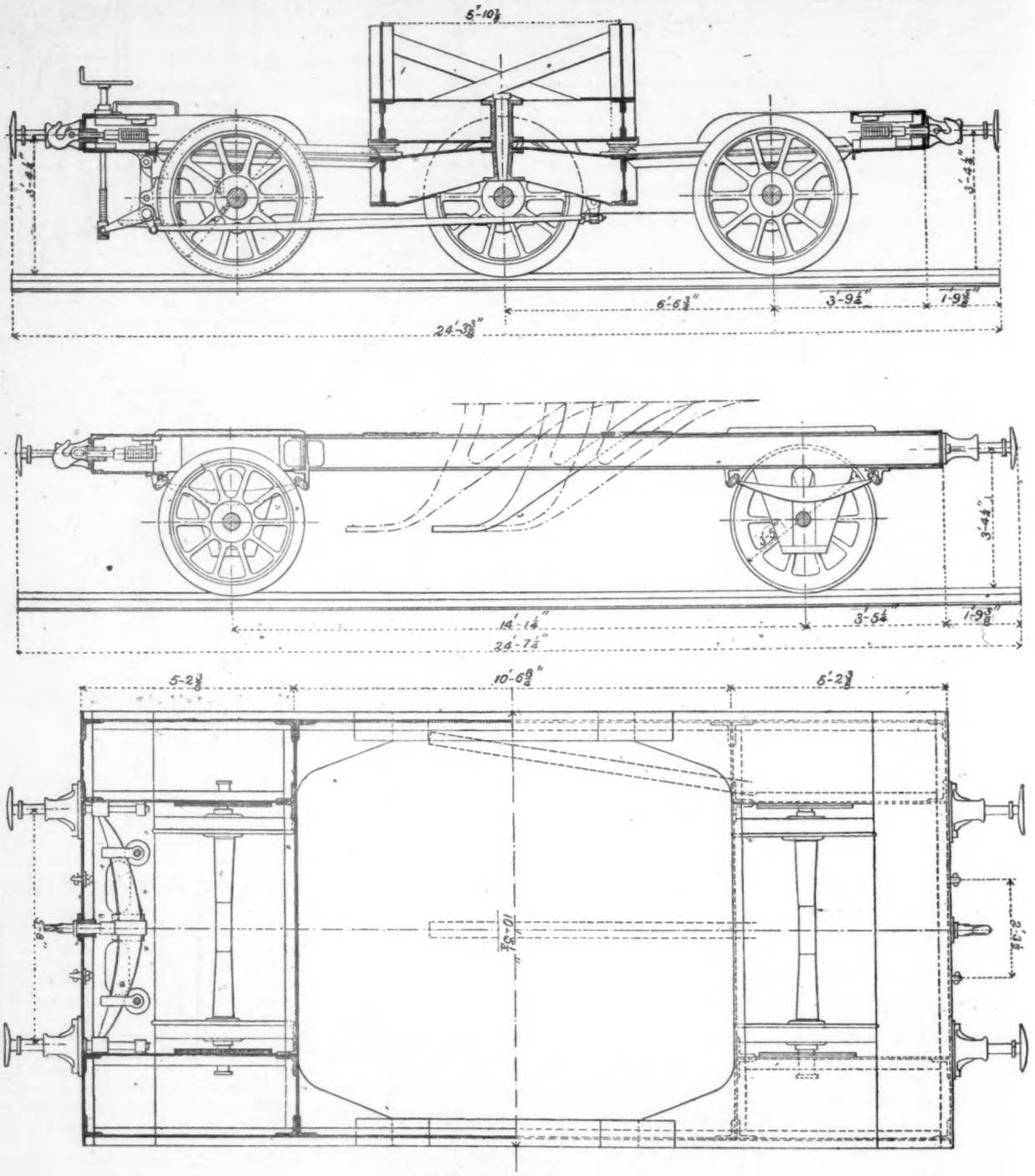


EXPRESS LOCOMOTIVE FOR THE WURTEMBERG STATE RAILWAYS.

placed by the passage of rapid trains, so that it might possibly come nearer obstructions which stand alongside the track. In order to make certain of the possibility of the passage of a torpedo boat, and determine what work was necessary to be done in order to accomplish it, the companies had a car run over the route which had projections upon it that represented

effected even in the old line from Mezidon to Mans were very slight indeed.

As the method of setting the torpedo boat upon its truck might lead to serious accident, either to the boat itself or to the truck, the railroad company stipulated that the consequences thereof should be at the expense of the Navy Depart-



Figs. 1, 2, and 3.

SPECIAL CAR FOR TRANSPORTING TORPEDO BOATS.

the most prominent parts of the boat and its hull. This contour model, shown in fig. 9, consists of a section of planks fixed at the back end of a brake van, and boarded by a double fringe of lead stems having a length of from 2 in. to 4 in. The contact of the walls of the permanent structure or obstacles of that kind would show themselves by the breaking of the model or the bending of the shoulder or angle stems. These tests were repeated two or three times, and favorable results were obtained therefrom. The changes that had to be

ment. It agreed to have the train accompanied by competent representatives, who should verify the load along the route and readjust it whenever the necessity should arise. The transportation was made by a special train. The running speed was limited to 15½ miles per hour on a straight line and 18⅝ miles at most in case of delay. The passings at stations were to be made only at a foot pace. The expense of transportation was fixed at 5 cents per ton per mile plus 8 cents per ton for the right of way, with a minimum of $1 per mile

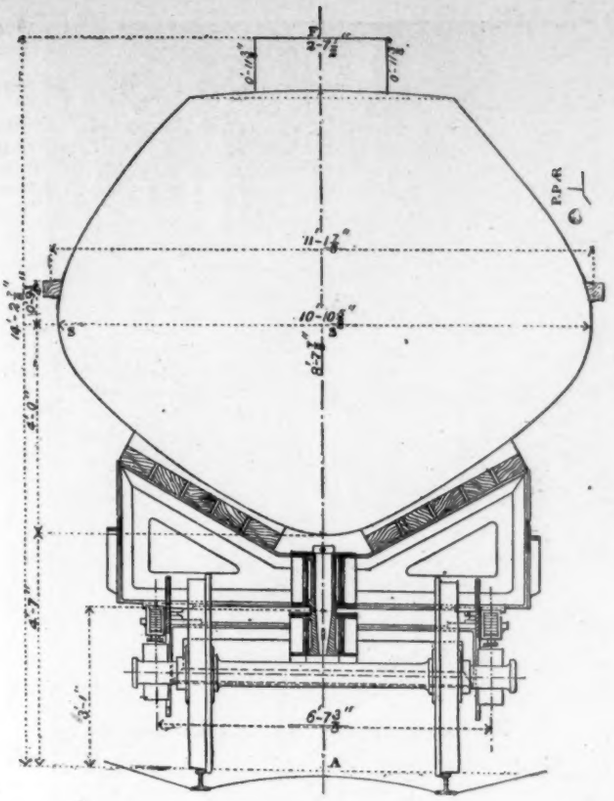


Fig. 4.

CROSS-SECTION OF CRADLE FOR CARRYING TORPEDO BOAT.

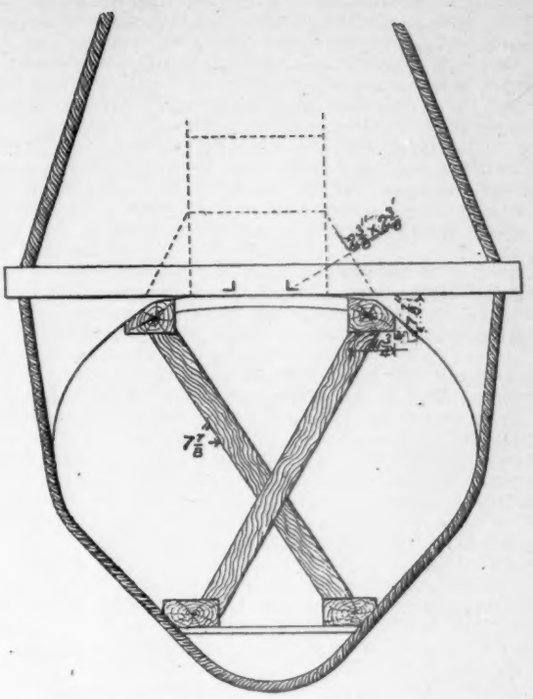
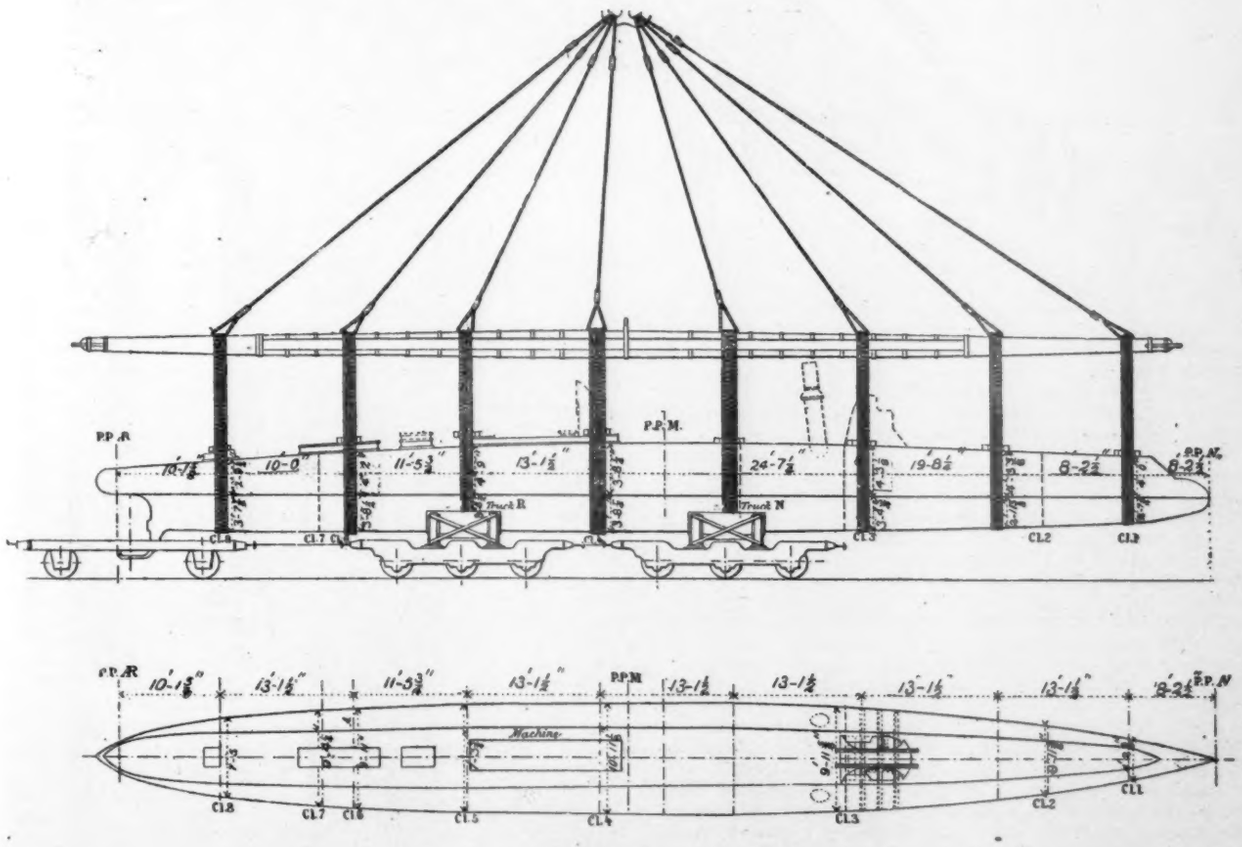


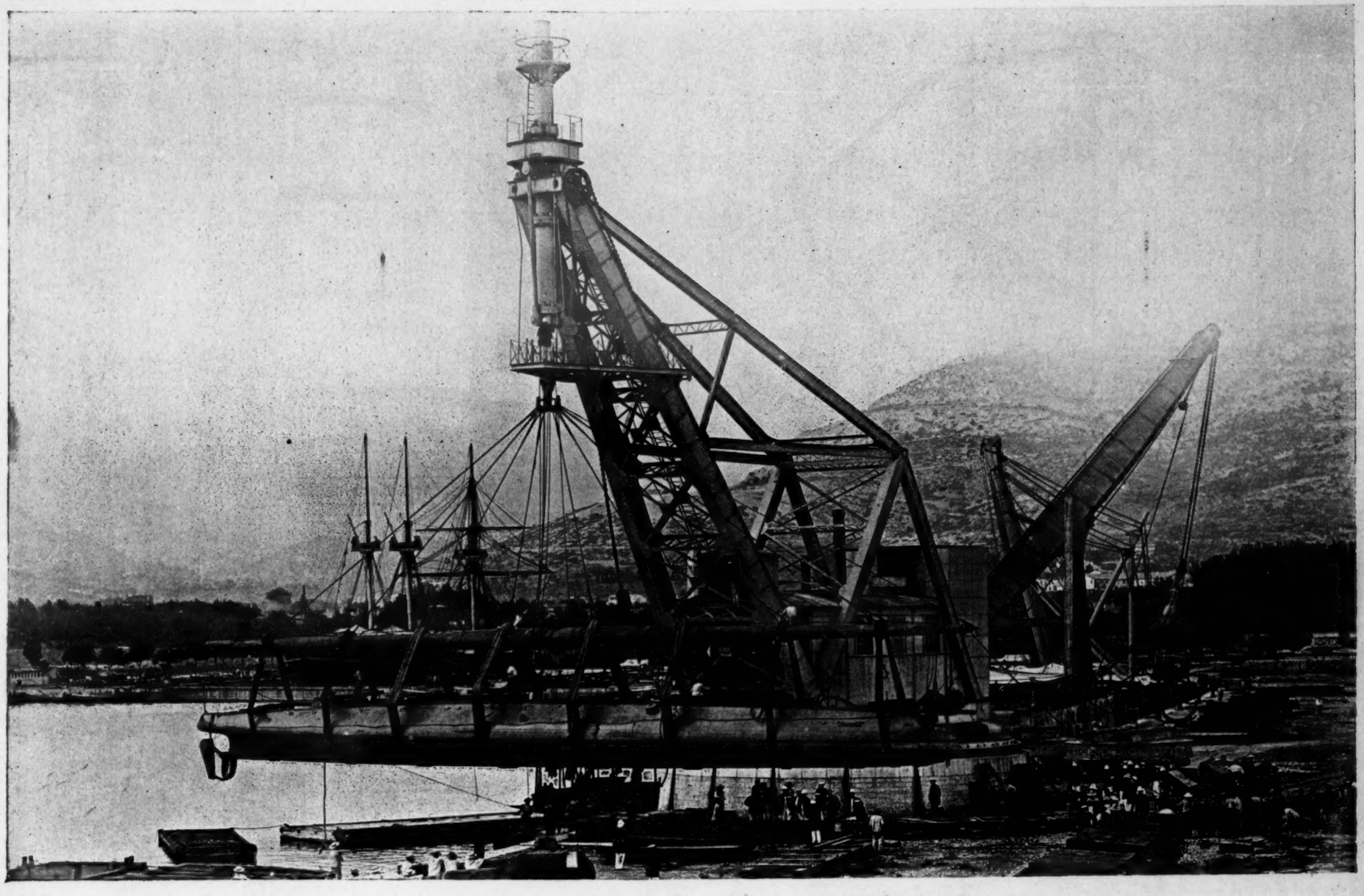
Fig. 7.

ST. ANDREW'S CROSS USED FOR STAYING INTERIOR OF TORPEDO BOAT WHILE IN SLINGS.



Figs. 5 and 6.

METHOD OF ADJUSTING SLINGS ABOUT TORPEDO BOAT FOR HOISTING AND PLACING ON CAR.



HYDRAULIC CRANE IN NAVY YARD AT TOULON, USED FOR LIFTING TORPEDO BOAT FROM THE WATER AND PLACING ON TRUCKS.

run by the special train. These different conditions having been agreed upon by the railway companies, the Minister of Marine made a contract with the Creusot Company for the manufacture of the trucks. The material ordered consisted of two bogie trucks of three axles each, with two cradles or racks for carrying the torpedo boat to be placed upon them. A special car was made to carry the sternpost of the boat with two flexible hauling chains. The Creusot engineers, under the direction of the Navy Department, made a careful examination as to the best method of constructing these trucks. It was originally intended that they should be built of wood and iron. The wooden cradles were to turn in arcs of a circle made of iron resting upon the bolster of a truck, just as long timbers are now carried on cars. The trucks and cradles as finally built were made entirely of metal, as shown in figs. 1 to 4; the angle which the cradle could describe was very small, and iron was replaced by four elliptical supports made of bronze, including a portion of the same arcs of a circle; the cradle rested upon a bogie by spherical bearing of the same metal sliding upon the oiled surfaces of these supports. The principle of dropping the side beams of the truck down between the axles in order to lessen the height of the torpedo boat from the rail was employed. Tender-axles were used for the wheels. The bearings of outside axles were furnished with radial boxes on the inclined plane principally to facilitate the passage around curves of short radius. The torpedo boat rested upon a cradle through wooden liners packed with oiled waste. The trucks were made to carry 20 tons each, and were delivered and tested under such a load, but later, in consequence of the examination into the subject by the Paris, Lyons & Mediterranean Company, it was thought that they could carry the 25 tons very readily.

It was found that in order to transport the torpedo boat, it was very essential that the sternpost, which carries the rudder and surrounds the screw, should be carefully supported, as it could not be removed without injuring the strength of the vessel. The result of this was that it was found necessary to build a special car composed of a framework carried on wheels and across which the sternpost could move on curves. The special car, an engraving of which is shown in figs. 1 to 4, was designed at Creusot. The plans for this material being approved by the Minister of Marine, after having been subjected to the approval of the engineers of the department, were sent to me. The expense of the material was $6,137 and is the property of the State, and will be used for any transportations of this kind that may be required in the future. The engineers of the Navy Department also investigated as to the best means of loading torpedo boats upon this new device. They agreed upon the me hod shown in figs. 10 and 12, which was used at Toulon. The boat, strengthened on the inside by a St. Andrew's cross, was surrounded by eight slings or bands, all of ropes, the upper part of which passed over a long boom parallel to the center line of the torpedo boat. This boom was fastened by eight balancing lines of wire rope to the hook of an hydraulic crane. The horizontal stays placed above the boat at each sling prevented the two sides from crowding in and crushing the boat. The same system was used at Cherbourg for lowering it into the water, but the number of suspension lines was reduced to six. The Navy Department has the necessary cranes at Cherbourg and Toulon for raising a small boat, and all of the other necessary arrangements for lifting.

In the April issue of the THE AMERICAN ENGINEER AND RAILROAD JOURNAL a description and engraving of the 160-ton crane, which is in use at Her Majesty's Dockyard, at Chatham, England, was published. The crane which was used for hoisting the torpedo boat out of the water at Toulon and placing it on the trucks has the same capacity, and has been in operation at the arsenal of Toulon for the past ten years. There is also a similar one at Brest, but of a still larger capacity. This crane has, as we have already said, a capacity of 160 tons, an outline of which is given in a small engraving, and its general appearance is clearly shown on the full-page reproduction from a photograph taken at the time when it was lifting the torpedo boat from the water. It is built upon the quay of Missiessy, where it handles enormous weights in the form of the heavy guns that are presented for installation in the batteries of modern vessels of war. This crane was built by Bon & Luestromont, and, like the one at Chatham, has a peculiar characteristic of using water under pressure instead of a chain as a means of transmitting power from the steam-engine to the hook intended to lift the weight.

It is composed of an iron skeleton forming an articulated system, and composed of a jib made of two backstays, tie beams and braces which are required to hold the jib, and a horizontal platform upon which the balancing counterweight, the boiler and engines are placed.

The crane turns about an iron pivot fastened to a cast-iron plate embedded in the masonry, which is, in turn, supported by 250 piles. It turns on a circle of loose rollers, which in turn roll over a circular track. The loads are lifted directly by a piston, which moves in a vertical cylinder located at the head of the jib. The piston is driven by means of water under pressure of 1,400 lbs. per square inch, which is furnished by a 24 H.P. steam-engine coupled directly to three pumps and fed by a boiler working under a pressure of 85 lbs. per square inch, having 323 sq. ft. of heating surface. The delivery pipes from the pumps are in communication with an accumulator formed of a cylinder, in which a piston carrying a charging load moves, and which is so adjusted that the piston rises when the water pressure reaches 1,400 lbs. per square inch. Before reaching the upper limit of its stroke, the accumulator automatically moves a tappet which closes the

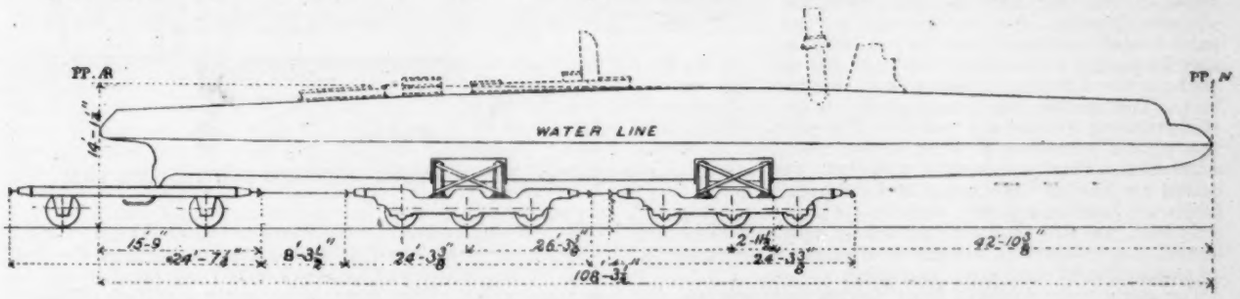


Fig. 8.

OUTLINE OF TORPEDO BOAT IN POSITION ON TRUCKS.

steam-pipe to the engine cylinders. The crane is also provided with a turning pivot and a hauling capstan moved by a small hydraulic engine, friction clutches permitting it to work in every direction. Finally, weights of less than 22,050 lbs. are raised by means of a chain passing over a pulley fixed at the head of the jib and driven by a special hydraulic piston. This piston is so geared that a stroke of 3.28 ft. produces a lift of 19.68 ft. at the hook. The expense of the crane was about $39,900, of which $6,650 were for the foundation. This apparatus has always worked perfectly since it was first put in service, and is considered a worthy example of French engineering construction.

Everything being ready, the Minister of Marine chose a torpedo boat of 108 ft. 3 in. in length for the trial. It being at Toulon, it was decided that the transportation should take place in the opposite direction—that is to say, from Toulon to Cherbourg. The torpedo boat No. 71, of 108 ft. 3 in., was built in Havre, by Normand, and was under the command of a Lieutenant Bachmes. The material built at Creusot was sent to Toulon. The setting upon the trucks was accomplished without any difficulty. The beam, hung from a hydraulic crane, was lowered to a point over the boat. Each sling was composed of a rope passing eight times around the boom, being carried under the vessel by two divers. These slings were almost exactly like rigid connections, and the lifting of the boat on to the trucks was accomplished without any difficulty. Finally, to make sure that the overhang should not bend, and, in any case, in order to determine the limits of deformation which might be produced, the boat was left for 40 hours simply resting in its cradles and without any other support. It was found at the end of that time that the boat showed no signs of straining. The Paris, Lyons & Mediterranean Company having verified the load, remarked that the center of gravity of the boat not being in the center of its length was therefore not an equal distance from the two

trucks, so that the weight carried by each of them was not the same. One of the trucks carried 11 tons, the other 27 tons, which made 12.3 tons per axle for this truck, including its own weight and that of the cradle. To equalize this load and raise that of one of the trucks to 20 tons, the maximum calculated by the Creusot Company for the side beams, it was necessary to shift the torpedo boat 5 ft. 10½ in. ahead. The overhang at the front end then became 42 ft. 10½ in. The change in the direction of the route compelled the Paris, Lyons & Mediterranean Company to run the contour car over the line which the torpedo boat was to traverse. This second experiment merely confirmed the results which had already been obtained. Finally the Navy Department was compelled to enlarge the entrance gate to the Cherbourg arsenal, and to pierce the interior wall and to modify the track beyond this wall in order to prepare for the passage of a curve of 459 ft. radius. The first movement was made from the arsenal to the Polytechnic School of Toulon. The curve of small radius surrounding the basin was passed successfully, and the return by backing was made without any difficulty.

Then a trip was made as a preliminary test between Toulon and La Ciotat, which was about 18¾ miles distant. The train ran first from the arsenal to Seyne, made a turn about the dock, running along curves of 492 ft. radius, and then ran toward La Ciotat and came back without any difficulty into Toulon. The carrying of the torpedo boat was perfect in every particular, and the oscillations to which it was subjected did not cause the slightest trouble. One of the axles of the truck heated considerably on the run, but this very frequently occurs when new material is used for the first time under a very heavy load. The special train passed another train while running without any trouble. The test was perfectly successful from a technical standpoint. Finally a serious accident occurred on leaving the arsenal at La Seyne. Inspector Bonnemain, who was on the torpedo boat, was thrown upon the track by telegraph wires, and had his foot crushed by the wheels of one of the cars, so that an amputation of the leg was necessary.

The route to be followed from Toulon to Cherbourg had been laid down by the railroad companies, who had agreed to the running of the train over their lines. The line chosen ran by way of Marseilles, Tarascon, Remoulin, Pont-Saint-Esprit, Peyraud, Firminy, Montbrison, Thiers and Moulins, on the Paris, Lyons & Mediterranean Line; by way of Montlucon, Vierzon, Tours, Le Mans over the Orleans Railway; and Mezidon and Caen on the Western Road. The total distance between is 848 miles. The running of the train at the rate of 15½ miles an hour at the maximum was calculated under two hypotheses; the first took it for granted that there would be no stop which would necessitate a night service under certain parts of the road. The start from Toulon was fixed at 6.30 in the morning of the first day, and the arrival at Cherbourg would have been at 7.45 on the evening of the third day, the duration of the run being 61 hours, 51 minutes. The second schedule was laid out with the idea that the train should stop every evening and should not travel at night. The start from Toulon was also placed at 6.30 on the morning of the first day, but the arrival at Cherbourg would not occur until 7.54 on the evening of the seventh day, after a trip of 157 hours and 24 minutes. Although the duration of the trip was lengthened by 96 hours, 9 minutes, or four days, the Navy Department preferred the second itinerary, on account of the care which would have been necessary for the first trial, as well as for the watchfulness which would have been necessarily incurred along the line and the saving of night work. It was understood definitely with all of the companies that the passenger service on all of their roads should not be modified, and that the special trip train should await their passage, but that, on the other hand, the freight train should wait for it.

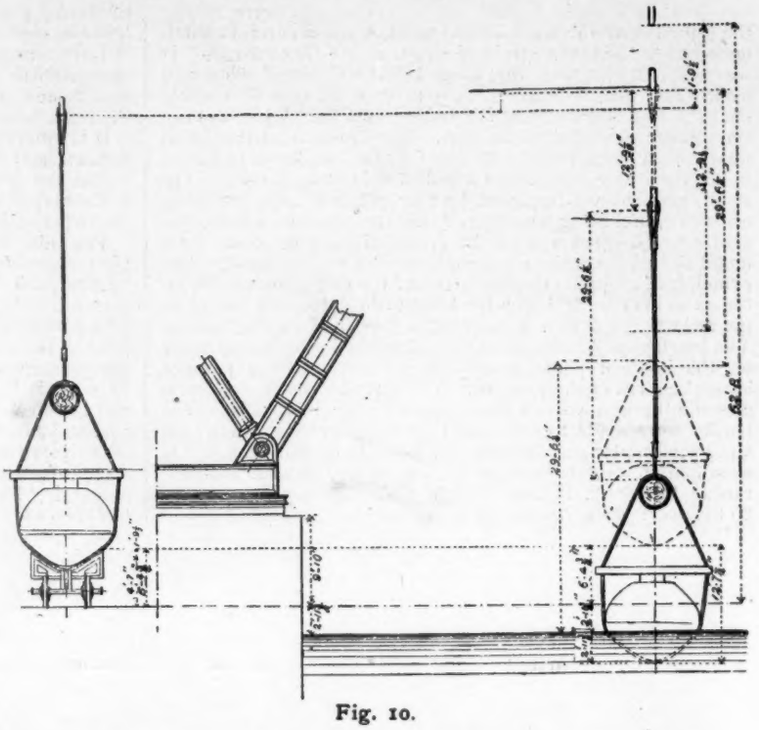


Fig. 10.

DIAGRAM SHOWING LIFT OF CRANE REQUIRED FOR TORPEDO BOAT.

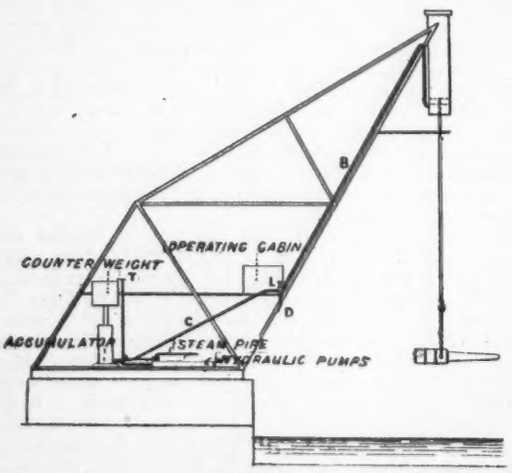


Fig. 11.

OUTLINE DIAGRAM OF CRANE.

A new verification of permanent structures along the line from Mans to Mezidon caused the Western Company to ask that the guard rails and engine-room projections should be removed from the torpedo boat. The lead stems forming the fringe of the contour car had touched a tunnel, and 14 permanent structures and the planking showed that the projections of the engine would have scraped the posts of six others and been broken. The lateral projections had touched certain loaded cars and even the lanterns of trains that had been passed. The work demanded was done, but it caused a great deal of difficulty, especially when it came to the matter of the angle irons holding the guard-rails; these angle irons were riveted to the main scantlings on the inside of the boat, and to detach them involved considerable work, especially in the water-tight partitions. Finally, at Toulon, a loading model with a contour of planks of the same kind as that used upon the railroads was placed in the arsenal, and it permitted the train to pass without any accident.

The final composition of the train included an engine and tender, a brake van for the conductor, a tool car, a passenger car, and a car for assistants; two platform cars without any side bars served as sustaining cars under the front end of the boat. They were attached to the two trucks and to the special car built for the sternpost. The latter was followed by a second tool car, and a brake van was used for a lookout. From the car occupied by the assistants all the movements of the torpedo boat were watched, and especially the oscillations of its overhang. One of the tool cars contained the armament

of the boat, and the other the conning tower, smoke-stacks, and those parts of the boat which had been taken down for transportation. Everything being thus prepared, the attempt at transportation having been made to La Ciotat, the train left Toulon for Cherbourg at 22 minutes past 6 in the morning. During the trip each company sent a section man with the

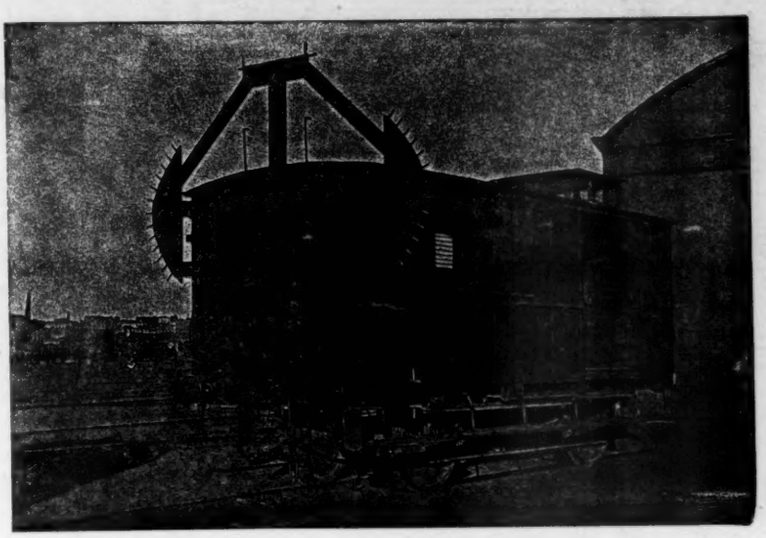


Fig. 9.

CONTOUR CAR FOR TESTING CLEARANCES OF PERMANENT STRUCTURES.

train, as well as a general inspector and a representative from the locomotive department. No accident occurred on the route, although the axles of some of the trucks heated, and one especially so, but not to such a degree as to hinder the transportation nor to cause any delay in the running of the train. The heated axle was cooled by putting a mixture of oil and flour of sulphur in the oil-box. The total amount of the oscillations of the front end of the overhang did not exceed from 4 in. to 6 in. Between Tours and Le Mans the maintenance department of the Orleans Railway lowered the track considerably, without which this work would have incurred further difficulties. Also some disks and other permanent structures had been removed as the necessities have indicated.

Starting from Le Mans, the two lead stems which corresponded to the projections of the angle irons holding the guard-rail of the torpedo boat passed everything without touching it. The wood of these guard-rails having been taken off for the trip, it became important to demonstrate the possibility of maintaining the angle irons in place without taking them down, as the replacing them would necessarily involve considerable work. It was also seen that the track would admit of a greater breadth than that of the torpedo boat of 108 ft. 4 in. in length. Between Dissay and Le Mans and between Carentan and Cherbourg the speed was increased without any trouble to 21¼, and even 25 miles per hour. During the run the train stopped at Pont-Saint-Esprit, Firminy, Moulins, Saint-Armand, Tours and Argentan. The torpedo boat had then passed the Auvergne Mountains. From all parts the people collected along the line of the road to see a war vessel, and one of such recent invention, passing over France on a railway. Those who took part in the trip will never forget the interest and the curiosity which everywhere centered about this strange object. The torpedo-boat train reached the Cherbourg station on September 2 at 7.50 P.M.

In the morning of September 3 the train, which had been standing in a station on a special side track, was run into the Cherbourg arsenal, where everything was ready for setting the vessel in the water, but the rivet holes of the guard-rails did not permit this work to be done at once, and it was here found that the whole had been subjected to no strain and had incurred no alteration during the trip.

Immediate attention was then paid to the rearmament, but the riveting and relocation of the guard-rails required some time, and the vessel was not in the water again till September 12. This was merely a repetition of the operation of setting it on the trucks. The commission which had charge of the torpedo boats and took control of the test stated that it had lost nothing in speed, and that its hull, boiler, engines, and military apparatus had suffered in no way by this transportation over the railroad. The torpedoes alone were slightly out of order, but this disadvantage was not a serious one, and the boat on its arrival was equipped with torpedoes that were already prepared. It must be remarked that those which had come from Toulon were in boxes placed in one of the brake vans of the train, and their disarrangement did not at all depend on the movements of the boat during the trip.

The expense of work preparatory to transportations of this kind has been placed at $114 per boat at the starting-point and at the point of arrival. In addition to this, $2,578.5 were paid to the railway companies. The amount which they received was just about equal to their disbursements. The time of preparation of the boat for transportation and rearmament was about 20 days, on account of the difficulties offered by taking down of the engine-room projections, and especially the angle irons holding the guard-rail. It is possible to diminish this delay very considerably by keeping the angle irons, the guard-rails, and the engine-room projections in place, and making a few modifications in overhead work, such as the stacks, the fastenings of the conning tower, and other deck projections. Lieutenant Baehmes estimates that this work can be easily reduced to 8½ days, four of which can be occupied in the trip. The itinerary laid down by the railway companies showed that by running at night with a speed of only 15½ miles per hour, the trip could be made in 61 hours, or 2½ days. Thus at the end of 7 days the vessel, from being ready to go to sea at Toulon, would be ready to leave Cherbourg for its new destination.

The trial has therefore been very successful, and it has been demonstrated that it is possible to carry torpedo boats having a length of from 108 ft. to 130 ft., over a run of 848 miles without any trouble. Their transportation from Toulon to Cherbourg, including disarmament and rearmament, could be accomplished in 7 days, while the voyage by sea would require 20 days. In the latter they encountered all kinds of dangers, especially those that were shown to exist near Cherbourg on March 22, 1889, or those which involved the loss of *L'Avant Garde* on the shores of Portugal in February, 1890. Torpedo boats which have made the passage by way of Gibraltar have reached port with their hull and boilers strained, requiring extensive repairs; whereas those which had come over by rail would be ready to go into service at once. In case of war the trip from the Mediterranean to the ocean or to the English Channel and inversely could be made rapidly and with absolute security. Finally, in the same instance, a torpedo boat would be delivered at any point reached by railways where a track of standard gauge has connections, and the Navy Department could prepare in all ports, which it would consider advisable, inclined planes or other means for placing the vessel in the water or for loading it upon the trucks. These are the results which have been demonstrated by the trial transportation of a torpedo boat from Toulon to Cherbourg.

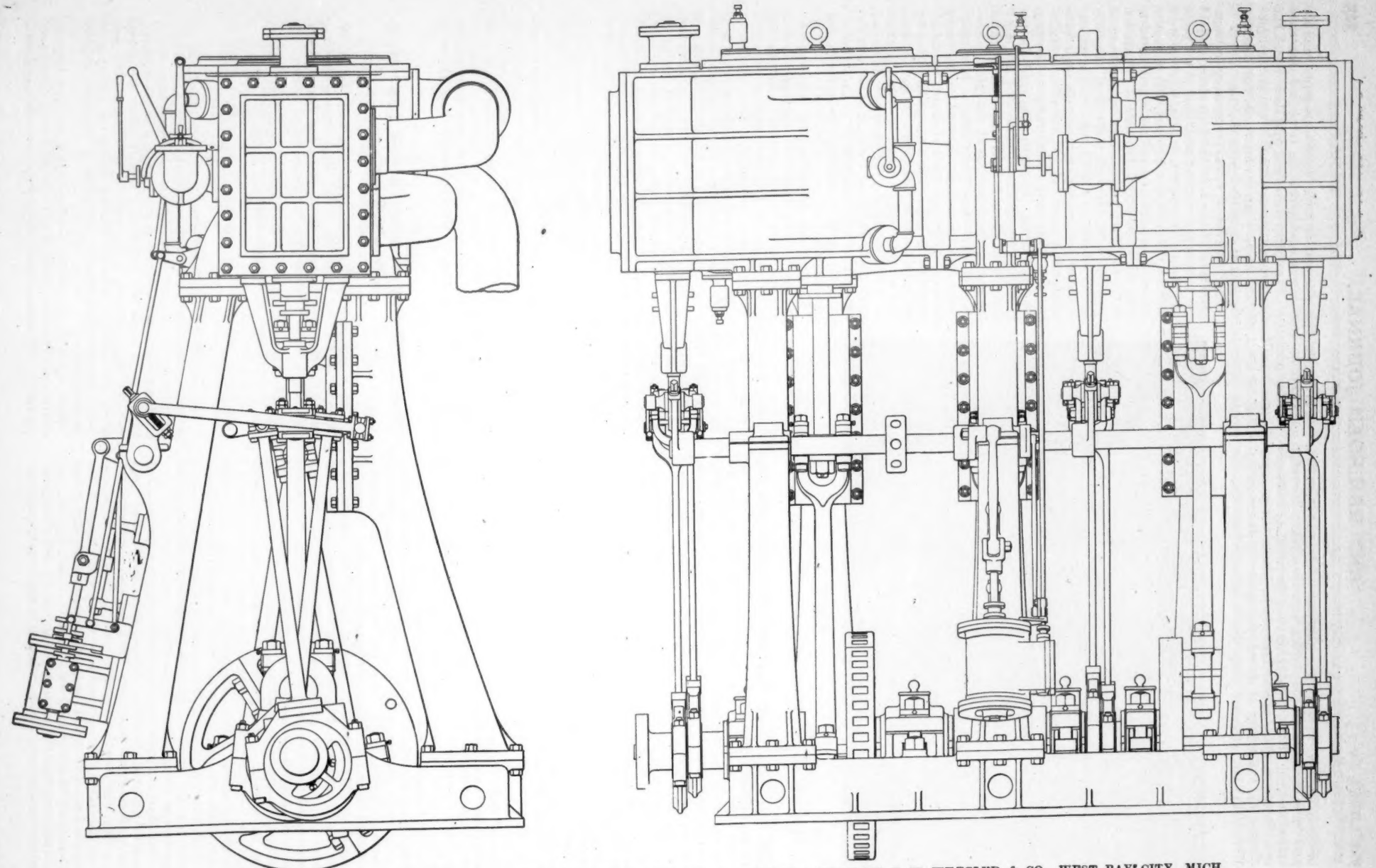
TRIPLE-EXPANSION ENGINE FOR TUG "W. G. WILMOT."

THE engine published in this issue was built by F. W. Wheeler & Co., of West Bay City, Mich., for a steel tug named in honor of her owner, *W. G. Wilmot*, of New Orleans, La. The general dimensions of the vessel are as follows:

Length over all	110 ft. 6 in.
Length between perpendiculars	99 " 6 "
Beam, molded	23 " 0 "
Depth, molded	12 " 6 "
Draft of water	11 " 0 "

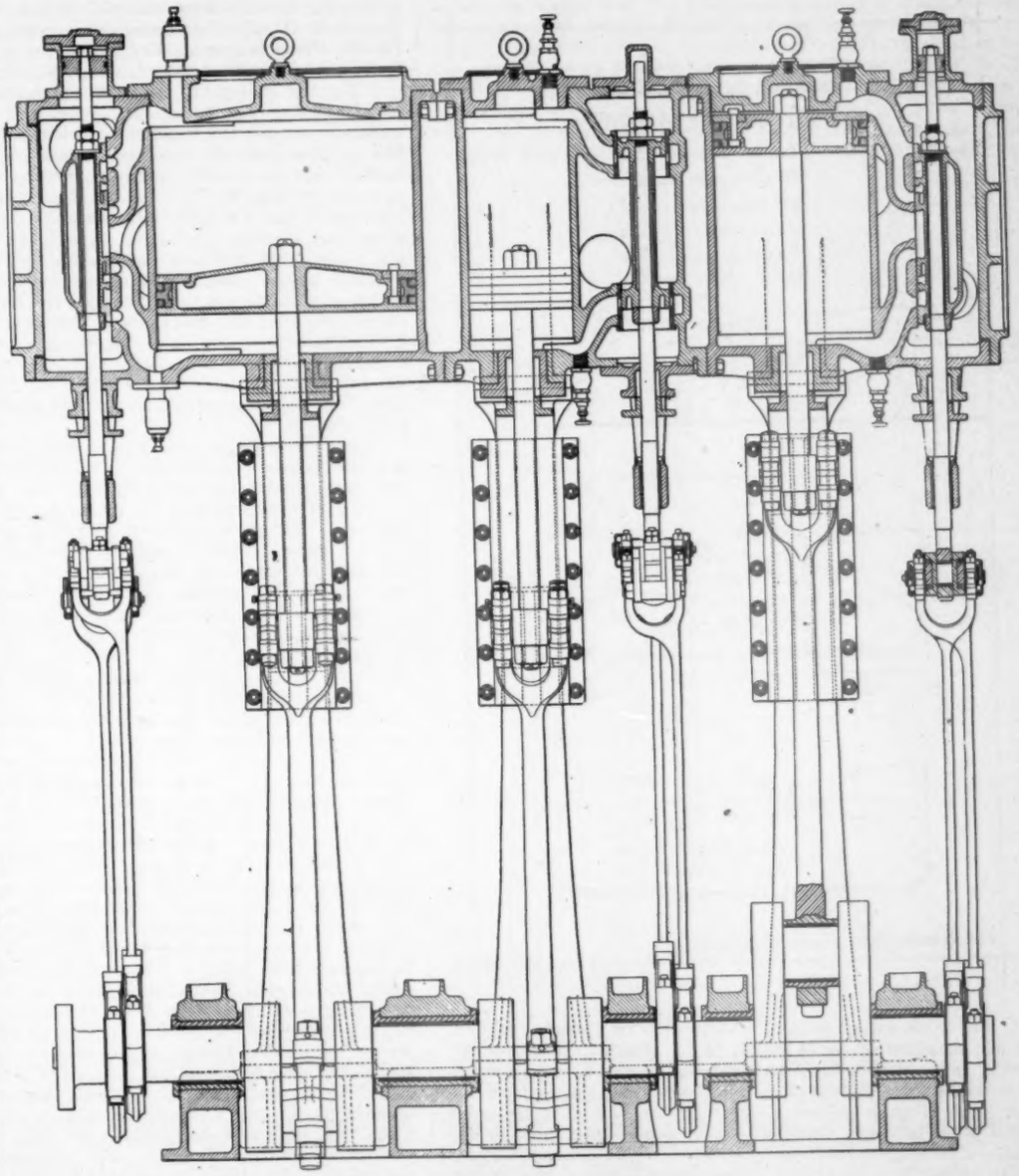
The propelling machinery consists of an inverted, direct-acting, surface-condensing, triple-expansion engine, with cylinders 16 in., 24 in., and 40 in. diameter, and a stroke of 28 in., driving a right-handed screw propeller 9 ft. 6 in. in diameter, with a mean pitch of 12 ft. 6 in. The cylinders are placed with the high pressure in the middle, the intermediate forward, and the low pressure aft, this being the sequence of cylinders generally adopted by the majority of engine-builders on the lakes.

Each cylinder is fitted with relief valves, top and bottom, and the low-pressure cylinder is provided with a 2½-in. starting valve. All steam-ports and passages are calculated for a



END AND SIDE ELEVATIONS OF TRIPLE-EXPANSION ENGINES FOR TUG "W. G. WILMOT," BUILT BY F. W. WHEELER & CO., WEST BAY CITY, MICH.

piston speed of 650 ft. per minute, with a flow of steam of 9,000 ft. per minute for steam passages and 6,000 ft. per minute for exhaust. The ports in the high-pressure cylinder are 1⅞ in. deep and 13 in. wide. The intermediate-pressure cylinder has two 1½-in. × 19 in. ports, and the low pressure cylinder has two 1⅝-in. × 36 in. wide ports. The main steam-pipe is of copper 5 in. inside diameter, the intermediate receiver pipe is 8 in., and the low-pressure receiver-pipe is 10½ in. in diameter, the exhaust-pipe leading to condenser being 12 in. in diameter. The throttle-valve is of the balanced type, and fitted with a suitable relief-valve, so as to work free and easy. The high-pressure cylinder is provided with valve-chest liners of hard, close-grained cast iron with diagonal bridges and ports 1½ in. deep. The piston-valve is solid, 7½ in. diameter, and fitted perfectly steam-tight in liners; lap on top is 1⅜ in. and 1½ in. on bottom; no inside laps. The intermediate-pressure and low-pressure cylinders are fitted with common double-ported slide-valves, perfectly balanced by cylinders and balance pistons of 4½ in. and 7 in. diameter respectively on top of steam chests. The intermediate-pressure valve has a steam lap of $1\frac{5}{16}$ in. on top and $1\frac{3}{16}$ in. on bottom, and the low-pressure valve has $1\frac{5}{16}$ in. lap on top and $1\frac{1}{16}$ in. on bottom. All valves have a travel of 4⅛ in. and are worked direct by the Stevenson double-bar link-motion provided with adjustable cut-off arrangement. Steam is cut off at about .7 of stroke in all cylinders when in full gear. All valve-stems are of best machinery steel and 2½ in. diameter. The engine is provided with steam reversing gear, having a cylinder 10 in. diameter and 12 in. stroke operated by a differential valve-motion from the engineer's platform. The pistons are of cast iron 6 in. deep, and are fitted with the usual lake style of self-setting spring rings. The piston-rods are of best machinery steel 3½ in. in diameter, secured to cross heads and pistons by tapered ends and nuts. The cross-heads are of wrought iron with gudgeons and slippers forged on. The slippers are provided with brass jibs 8½ in. wide and 12 in. long. The connecting-rods are of wrought iron 6 ft. between centers, having the upper ends forked to span the cross-head jaws, which are 3½ in. long and 3½ in. diameter. The upper ends are turned to a diameter of 3⅜ in. and 4 in. at the lower ends. All connecting-rod bolts are of steel 1½ in. diameter at the upper ends and 2 in. at the lower ends. The crank pin brasses and all main journals are lined with Magnolia anti-friction metal strips. The cylinders and valve-chests are covered with magnesia covering and lagged with highly polished birch. They are supported by six cast-iron columns, the port columns being provided with large bearing surfaces and water-jackets for slides. Through-bolts are used wherever practical throughout the whole engine. The bed-plate is the box type cast in one piece, having five main journals, each journal having two 2½ in. holding-down bolts and cast-iron caps. The crank-shaft is made of best wrought iron of the built-up type 8 in. in diameter. The thicknesses of crank arms are 4⅞ in. for intermediate pressure, 5½ in. for high pressure, and 5⅞ in. for low pressure, with a common width of 15½ in. The crank-pins are all 8 in. diameter and 8½ in. long. The cranks are placed 120° apart, with the low pressure leading high pressure. The thrust-shaft is 8 in. diameter, having the collars forged on, 14 in. diameter and 2½ in. thick. The thrust bearing is of the horseshoe type, with three cast-iron collars lined with graphite metal and adjustable by means of strol-bolts and brass nuts. It is designed for a thrust of 50 lbs. per square inch, and provided with a line bearing 9 in. wide to support the thrust-shaft. A similar line-bearing supports the after end of thrust-shaft. The stern tube is 10 ft. long, made of cast iron, with internal bushings forward and aft. The forward bushing is of brass lined with lignum vitæ, and the after bushing is 34 in. long and made of hard cast iron in halves, so as to be easily renewed when worn. The propeller-shaft is 8 in. diameter and 8⅛ in. at bushings. Wrought-iron bands are shrunk on propeller-shaft at after-bearing to provide for the great wearing caused by

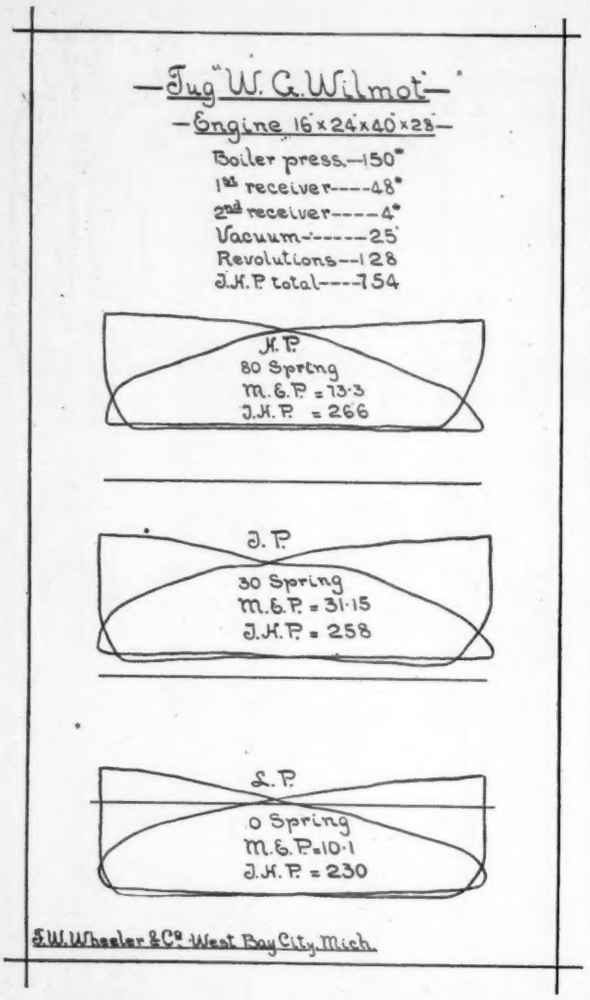


LONGITUDINAL SECTION OF TRIPLE-EXPANSION ENGINE FOR TUG "W. G. WILMOT."

the extreme amount of sand and clay found in the Mississippi River water. Experience has shown that cast-iron stern bearings are most suitable for service in these waters.

Steam is furnished by a cylindrical return tubular boiler 12 ft. 6 in. in diameter and 12 ft. 6 in. long, designed for a working pressure of 160 lbs. per square inch. The three furnaces are 40 in. inside diameter and 8 ft. long, giving a grate surface of 63 sq. ft, and the boiler has 218 3½ in. charcoal iron tubes 8 ft 6 in. long, with a total heating surface of 2,100 sq. ft.

All pumps are independent, and the condenser is of the Wheeler Admiralty Surface Condenser type, with combined



air and circulating pumps. Diameter of steam cylinder, 12 in.; diameter of air cylinder, 14 in.; diameter of water cylinder, 14 in., with a common stroke of 12 in. Cooling surface in condenser is 1,100 sq ft. The feed-water passes from the hot well through a feed-water filter in four compartments filled with hay and charcoal to the feed-pump, and is discharged through a feed-water heater into the boiler. The exhaust steam from all pumps passes through this heater, which is 24 in. diameter and 10 ft. long, and contains 70 1¼ in. brass tubes.

The maximum power developed by the engine under 160 lbs. of steam and when making 148 revolutions per minute is 850 indicated H.P., the vessel making 16 statute miles per hour. The indicator cards published herewith were taken when the engine was working 128 revolutions per minute under ordinary conditions, with 150 lbs. of steam and 25 in. vacuum. The engine was built from designs by Sven Anderson, Mechanical Engineer with F. W. Wheeler & Co.

The Dry Dock Iron Company, of Bay City, Mich., are now building one of their patent sectional cast-steel screw-propeller wheels for the *W. G. Wilmot*. The advantages claimed by this type of propeller are a saving in weight of about 15 per cent. over the ordinary sectional cast-iron wheels, less resistance caused by a screw-shaped hub, and greater strength gained by using the best cast steel made. Especially is the latter a desirable feature for lake vessels and river tugs striking snags and logs very frequently. As will be seen from the engraving, the blades are dovetailed in the hub and carefully fitted and fastened by means of steel keys. The new screw ferry steamer *Pleasure*, now building for the Detroit, Belle Isle & Windsor Ferry Company, is fitted with a 10-ft. wheel of this type, and the results will be looked for with great interest.

LIQUID FUELS.

Mr. G. Stockfleth, an engineering expert of the Noble Petroleum Production Company, recently read a paper on Liquid Fuels before an English technical society. The following is an abstract from it:

"The use of liquid fuel is by no means of recent date; it has for many years been pretty general in Russia, and the question cannot any more be considered as a problem which has to pass through its experimental stages. Before going further into the subject, it may be well to define which liquids can best be used as fuel. A good many oils might enter the list were it not for some indispensable requirements, such as cheapness, absence of danger, capability for developing heat and undergoing complete combustion, without producing unpleasant smells, smoke, and dangerous and unhealthy gases, which conditions practically reduce the number to the oils derived from coal and from crude petroleum. The first-named (oil derived from coal) is, however, not produced in sufficient quantities for even a limited consumption, and would be far too expensive to manufacture solely for fuel purposes. It is, therefore, to crude petroleum that we must turn for obtaining a suitable oil.

"Crude petroleum consists almost entirely of a mixture of a great number of hydrocarbons differing in boiling point and density, and, by being submitted to distillation, it gives a series of hydrocarbons known as gasoline, benzoline, kerosene, etc. It is not necessary here to give a detailed description of these different products. Suffice it to say that the first distillate of crude petroleum, which evaporates at a low temperature, is the most inflammable, and gradually, as the temperature is raised, the less dangerous oils are distilled, until the temperature in the stills reaches 300° C. to 320° C.; at this point the distillate is called kerosene, and the residue (which in Russian is called astatki) forms the oil which so admirably answers the conditions for a good liquid fuel. It contains all the heavy hydrocarbons capable of creating heat, and the high temperature to which it has been exposed having freed it from all dangerous volatile liquids, guarantees its complete safety; a match or any other naked light is immediately extinguished when plunged into it. In order to make it burn it requires special treatment, about which more shall be said presently. As astatki presents no danger whatever, it is in Baku stored in large open excavations in the ground, containing up to 5,000,000 poods each, equal to more than 100,000 tons. In some of the distilleries astatki is used as fuel under one still immediately after having been let out of another, which shows that even at a high temperature it can be handled with safety. The Russian crude petroleum gives about 35 per cent. benzoline, gasoline, and kerosene; the remaining 65 per cent. is used for the manufacture of lubricating oils and mostly as fuel. To give an idea of the extent to which it is used in Russia for locomotive, steamship, and even stationary boilers, it may be mentioned that the transport of astatki from Baku to the Caspian seaports and Astrakan, amounted, in 1892, to 107,361,435 poods, equal to about 3,000,000 tons; and, in addition to this, some 250,000 tons were shipped from Batoum. The statistics for 1893 are not yet available for reference, but will probably show an increase.

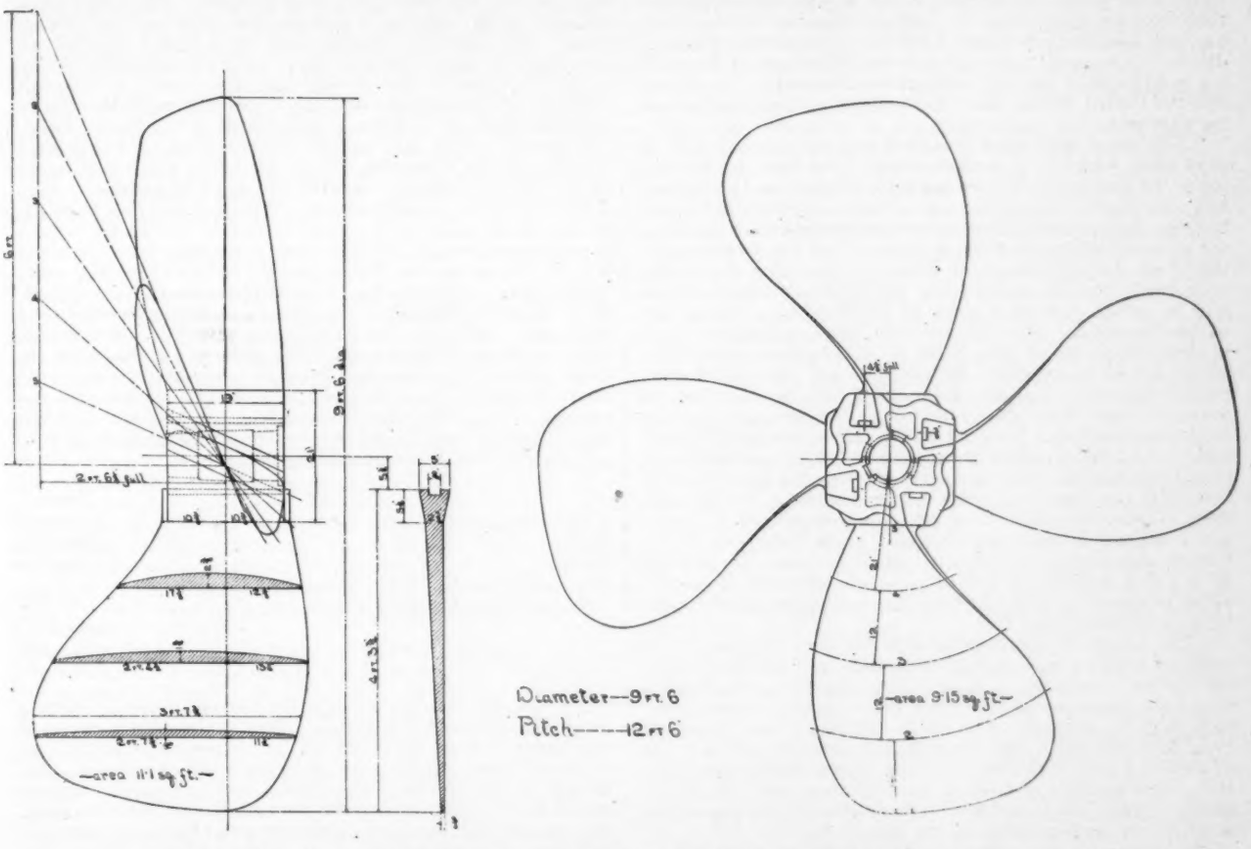
"For boiler and distilling purposes it is necessary to create a larger and more powerful flame, and steam is used for forming it into a spray which is easily ignited, and then burns fiercely. Many injectors or pulverizators in Russia, called fasunkas, have been constructed and patented, but it has been found that the most primitively constructed pulverizators answer as well as the more complicated kinds. The apparatus used under the stills consists simply of two ½ in. pipes, one leading the oil from a tank, the other steam from a boiler. The ends of the pipes are flattened by a blow of a hammer, and then tied together with a piece of wire; the steam jet catches the outflowing oil, and forms the spray. It is well to keep the oil a little warm to facilitate its passage in the pipes, through which it descends by gravitation. This pulverizator gives entire satisfaction; the flame is powerful and bright, and not a drop of oil is wasted when once the flow has been regulated. No smoke or flame ascends the chimney—which,

by the way, can be very short—as the steam jet itself creates sufficient draft. A somewhat neater appearance can be given to the injector when the oil-pipe is arranged inside the steam-pipe, and provided with a cast-iron or brass nozzle, which can be shaped to give the flame any desired form. As far back as 1880 I had occasion to make, on behalf of Messrs. Nobel Brothers, in St. Petersburg, some experiments with oil firing before a committee of the Russian Admiralty.

"Experiments have been made with compressed air for spraying the oil, but the results have not materially differed from those obtained with steam. Air must, of course, in any case, have access to the flame, and openings on the front of the flue must be provided for its admittance. In most cases the hole in the furnace door through which the nozzle of the pulverizator is introduced, is sufficient for letting in the quantity necessary for the combustion. By using steam for spraying, no oil accumulates in the flue when the flow is regulated, consequently a complete combustion of the oil takes place. Looking at the question from the point of cost, it is not probable that the compressed air can be produced cheaper than the necessary quantity of steam taken direct from the boiler. It is, in fact, but a very small quantity which is necessary for doing this work, when the pulverizator is properly constructed. The chief point in the construction of the pulverizator is to avoid waste of steam—that is to say, to construct the nozzle in such manner that every particle of steam takes care of a corresponding particle of oil. This object will best be secured when the openings for the steam, as well as for the oil, are made long and narrow, and are placed as close to one another as possible. All the different Russian constructions are made in this way. The openings are about 1¼ in. long, and ⅛ in. to ⅛ in. wide. As the oil sometimes contains paraffine, which is likely to choke this narrow opening, it is essential to have an arrangement by which steam can be led through the oil-passage to clean it out. The rest of the construction may be varied to suit particular cases, and with a view to facilitate and cheapen the manufacture." After mentioning the general advantages, the author spoke upon the special advantages accruing to railways and steamships. "The valuable spaces at railway stations, which have now to be sacrificed for accommodating coal supply, could be reduced by about two-thirds, as only half the tonnage would have to be kept in stock, and this quantity can be stored more economically in point of space than the same quantity of coal. A considerable amount of labor employed in storing coal and loading tenders can be saved, and the oil can be taken in simultaneously with the water supply, as quickly and in a like manner. The avoidance of smoke and blowing safety-valves will greatly add to the comfort of the passengers, a point for which the railway companies are usually prepared to make considerable sacrifices.

"For steamships the advantages of using liquid fuel are of still greater importance. The oil can be kept in ballast tanks at the bottom of the ship, an arrangement which greatly augments the stability of the vessel, and can, as it is consumed, be replaced by water. The size of the stokehold can be reduced considerably, and the number of stokers diminished in the proportion of one to four. In stormy weather it is of great advantage. The danger of fire in the coal-bunkers will not be replaced by any similar risk connected with the use of oil. Lastly, it may be mentioned that a ship having oil at its disposal may, by pouring a certain quantity overboard in rough weather, avoid much trouble. For torpedo-boats the use of liquid fuel is possibly of still greater importance than for any other vessels; the entire absence of smoke will help to avoid detection and possibly destruction, and the saving in space is of the utmost importance as well as the possibility of raising steam quickly. Oil-firing greatly increases the rapidity of raising steam of high pressure; fire-grate and ashpit can be done away with altogether, the length of the funnel can be reduced, and a system of water tubes is better suited to the fierce fire of liquid fuel than the straight or curved surface of an ordinary thick boiler plate. No boiler specially designed for liquid fuel is yet in the market, but the subject leaves certainly a wide field for the boiler designer who, with liquid fuel, can obtain a flame which can be controlled, directed, and given uniformity much better than a coal fire, and which is less dependent upon air-currents.

"A disposition to use liquid fuel has already been shown in this country, both for locomotives and steamships. A certain number of locomotives, and even stationary boilers, have been fitted to use oil, and have burned the tar oil which was ob-



SECTIONAL CAST-STEEL SCREW, BUILT BY THE DRY DOCK IRON COMPANY, BAY CITY, MICH.

tainable. A small quantity also of astatki, which had been shipped to this country, has been employed for steamship use.

"As regards the supply, America and Russia produce very different classes of crude oil. The American oil gives about 80 per cent. of kerosene, and the remainder is partly utilized for making other petroleum products. There is, therefore, no likelihood of getting any great supply from these fields. The Russian crude oil, on the other hand, only gives about 35 per cent. of kerosene and other products, leaving 65 per cent. of astatki for fuel; there are, therefore, if not unlimited, at least very considerable quantities at hand from these fields.

"At present no oil territories which approach the American or Russian in magnitude are worked."

The author mentioned various localities of an oil-bearing character, among others, Burmah, the West Indies, Canada, Mexico, etc.

"In Russia, boring operations commenced 20 years later (1879), and the number of wells drilled is considerably less, but they have been more productive than the American. On account of the different geological formations of these two countries, the modes of boring are different, as well as the form of the wells. In America a well is often drilled through rock from top to bottom; the average diameter is 8 in. at the top, and the depth is about 2,500 ft. A complete outfit for drilling such a well costs $10,000, and the wages of the drillers is $3 to $4 a day. If drillers are secured for work outside the United States, they receive $125 a month and traveling expenses.

"The safest and most practical way to proceed will, in most cases, prove to be the following: After thorough surveying of the particular field by competent experts and geologists, and after having located a number of places suitable for trial borings, the necessary plant has to be brought into operation, not so much with a view of getting hold of the largest quantity of oil, for the storage of which no provision has usually been made, but for ascertaining the depth at which the oil will be struck, and as a guide in defining the extent of the oil-bearing strata. For this purpose it is not necessary to go beyond the depth of, say, 1,000 ft. If the strata met with, which has to be carefully recorded, do not give satisfactory results, another place has to be tried, and so on, until the operators have thoroughly sounded the ground, and are perfectly convinced that plant for larger and deeper wells is justified. The cost of plant, the amount of skill required in the operations, and the time employed progress at a much quicker ratio than the depth; in other words, a 3,000 ft. boring costs more in money and skill than, say, five borings 1,000 ft. each; and a territory is much better tested by 20 borings of 500 ft. than by five borings of 2,000 ft. If oil is found only at 3,000 ft. in a new territory, it does not, in fact, present very encouraging prospects, unless, of course, the quantities found should be very considerable.

"The system to be recommended for such borings are the ordinary artesian well boring, with rods and ropes and portable derrick; for later borings a fixed rig iron and wood for use of the American and Canadian boring system, and heavier tools may be adopted. One outfit for every two, three, or even four test holes may be sufficient, and requires but one experienced man with two unskilled helpers for its manipulation. If steam power is used, an additional man will be required. Responsible technical supervision of the operations is, of course, indispensable in any case."

The discussion was opened by the Chairman, who said he could confirm what had been said as to the advantages of liquid fuel used on railway trains. Liquid fuel was adopted on one of the railways of Argentina in 1890, and there were 12 locomotives burning it. Within the last few months a petroleum-tank steamship had been driven across the Atlantic by liquid fuel. He also spoke upon the question of burners.

Mr. Nelson Boyd stated that the combustion of a hydrocarbon was much more perfect than that of coal, there was not the loss in smoke and clinker, and, in locomotives, there was none of that coating of the tubes with carbon. The great difficulty in England was the price, which was equal, at present, to coal at 23*s.* per ton. Another important point was the quantity of steam required for the pulverizators.

Mr. Edwin Harwood stated his experience in his yacht, the *Ruby*, remarking that his difficulty had been in the adjustment for the small amount of oil utilized.

Mr. W. Warren, Sir W. Percival, and others contributed to the discussion, giving their experience in regard to the use of liquid fuel.

The voyage across the Atlantic of the steamship *Baku Standard*, a short time ago, revived the question of the use of oil as a motive power for steamers and locomotives. About 10 years since the question was somewhat acute, but now we are enabled to take a more enlightened view of the subject. The question is of some importance to coal-raising districts like that of South Wales, hence a short summary of the position created may be of use and interest at the present time. The question revolves itself into two main considerations—is it possible to use petroleum or other mineral oils to such an extent as to curtail seriously the production of coal; and in so doing affect to a large extent the labor market of miners, seagoing firemen, and railway stokers? The latter part of the query, of course, depends entirely on the answer given to the former. Well, the facts may be briefly stated thus: There are a great number of steamers and locomotives (which are now driven by steam raised from petroleum) in the Caspian and the Euxine oceanic districts. A few steamers similarly ply on the river Plate, and a few are now making inter ocean voyages to America and the Black Sea; and the Great Eastern Railway, in our own country, has adopted the use of shale oil for the locomotives. So that there is no doubt of the practicability of the experiments. In 1885 the screw steamer *Himalaya* (afterward called the *Marahu* when taken to Brazil) made a trial trip from London to Granton. The result was a passage of 54 hours at a consumption of 8 galls. of oil per hour. The cost was estimated at £4 against a possible expenditure of coal of £7 per day. Only two firemen were required, in place of five if coal had been used. In the same year the Central Pacific Railway Company tried the oil plan on their steamers, oil having been found on the Pacific Coast. The cost of oil for their steamer *Thoroughfare* for five months was ascertained to be 56 per cent. of that of coal. Put in another way, it was found that 80 imperial gallons was equal to 1 ton of coal for steam purposes. The cost being as $4 to $7. In the recent case of the *Baku Standard*, the owners report that the mere weight of the fuel was at the same ratio—namely, 4 to 7. There was also a large saving of labor in engine-room department. If this be so, in the intense competition of trade, there must be a strong temptation to increase the number of tank steamers, and to use oil as a motive power. But as cost must be the governing factor, if the price of oil should rise, in consequence of an increased demand, reversion to coal would be very quick. Now, to test this point, let us consider the amount of oil production in the world. In 1889 a statistician computed the world's production of petroleum and its congeners at 10,500,000 tons made up thus:

	Tons.
United States of America	6,000,000
Russia	3,000,000
Galicia	1,000,000
Burmah, Canada, Peru, Germany, Roumania, Transcaspia, Australia, Japan, etc.	500,000
Total	10,500,000

Since then America has not increased much, if at all. Russia has about doubled her output. The probability is that, in this present year, the total output is about 14,000,000 to 15,000,000 tons. Taking the *Baku Standard* experiment, confirmed by that of the *Thoroughfare*, at 7 to 4 against coal, it would appear that, say, 15,000,000 tons of petroleum is equal, as a steam raiser, to about 26,000,000 tons of coal for the same purpose. The production of coal is over 500,000,000 tons per annum in the known world. How, therefore, can 15,000,000 tons of oil compete with such an enormous quantity of coal? It is alleged that the production of oil is unlimited; that it can be made from coal itself and other products; that the cost (or saving) in using it is as 4 to 7; and therefore it must seriously affect the production of coal in a very short time.

On the other hand, the arguments against the position are: That the more it is used the higher the price will rise, and thus level the cost of its use to that of coal; that in America many wells have run dry, and Russian and other sources of supply may also experience the same fate; and that the demand for oil at the present time (unlike coal) is mainly for domestic use, and for other purposes than steam-raising.

Altogether, at the present time, it would appear that coal-owners and their workmen may rest contented that petroleum cannot yet enter into the race of competition with them. It is true, however, that the Russian supply is increasing enormously, and that tank steamers are being built to a limited extent. As an index of what Russia is doing in the way of supply to other countries, it may be stated that in 1888 she exported 545,855 tons of petroleum, which in 1892 (only four years) rose to nearly double the quantity, or 900,887 tons.—*South Wales Investment Circular.*

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

VIII.—METHOD OF DETERMINING SILICON IN STEEL.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1891, by C. B. Dudley and F. N. Pease.)

OPERATION.

Put 2 grams of fine borings in a 12-oz. royal Berlin porcelain casserole, and add 80 c.c. of a mixture of nitric acid, sulphuric acid, and water. Cover with a watch glass and allow action to cease. Then evaporate, if desired, over a lamp direct, until sulphate of iron begins to separate, then transfer the dish to an air-bath, heated to about 300° F., and continue the evaporation until fumes of SO_3 are given off. Allow to cool, add 250 c.c. of distilled water, and heat carefully until the sulphate of iron has all dissolved, then filter at once. Wash with water until most of the iron salts are removed, and then with dilute hydrochloric acid, as long as the washings are colored with iron salts; finally wash with water again, until the washings no longer react for chlorine, then ignite and weigh. Treat the contents of the crucible with a little dilute sulphuric acid and a few drops of hydrofluoric acid, evaporate to dryness, ignite and weigh again. The difference between the two weights is silica.

APPARATUS AND REAGENTS.

It will be observed that a porcelain casserole is designated as the characteristic piece of apparatus for this method. Of course platinum dishes and good quality porcelain evaporating dishes may be used, but, all things considered, a casserole seems best. Glass should not be used, as some of the separated silica apparently adheres to the glass, and cannot be removed by the feather or rubber tube on the end of a glass rod. Direct experiments on the same steel, everything being exactly alike, except one determination was in a porcelain casserole and the other in a beaker, show lower results in the beaker, amounting to one or two-hundredths of a per cent. The results in the porcelain were confirmed by repeated tests in platinum on the same steel. For a single determination, the air-bath recommended in "The Chemical Analysis of Iron," by A. A. Blair, 2d edition, p. 20, is very satisfactory. For a number of determinations at once, an oven gives excellent results.

The mixed acids for solution are made by adding 20 c.c. of concentrated C. P. nitric acid to 40 c.c. of distilled water, and then adding to this 20 c.c. of concentrated C. P. sulphuric acid. Where a number of determinations are to be started at the same time, it is more convenient to mix the quantity of acids required all at once.

The dilute hydrochloric acid for washing is made by adding one part concentrated C. P. acid to four parts of distilled water.

Hydrofluoric acid of good quality, practically free from residue, can now be obtained in the market, in ceresine bottles.

CALCULATIONS.

Atomic weights used, oxygen, 16; silicon, 28; molecular formula, SiO_2. Since 46.67 per cent. of the SiO_2 is silicon, if the weight found is multipled by this figure, the result will be the silicon in 2 grams of steel, and this figure multiplied by 100 and divided by two obviously gives the percentage. This may be simply stated in the following rule: Express the weight of SiO_2 found, in grams, remove the decimal point two places to the right, and multiply by 0.2333. The product will be the percentage of silicon in the steel. Thus if the silicic acid found is 0.0027 gram, the silicon is (0.27×0.2333) 0.063 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method oxidizes the silicon in the steel by means of nitric acid, and then dehydrates the silicic acid formed by means of concentrated sulphuric acid, so that it can be caught in a filter, finishes the dehydration by ignition and weighs up as SiO_2. Any residue of iron or other material not washed out is left behind after the treatment with hydrofluoric acid. There is considerable evidence that the SiO_2 is not completely dehydrated in the sulphuric acid by this method. After the water is added and the iron salts are in solution, the appearance of the silica in the liquid is more or less gelatinous, also, as is mentioned below, the SiO_2 goes into solution again under certain conditions. It is believed that if the directions are carefully followed, the results will be accurate to within perhaps half a hundredth of a per cent.

The reason for the use of a porcelain casserole has already been given.

The mixed acid gives exactly the same results as though the steel is dissolved in dilute nitric acid, and then dilute sulphuric acid added. It simplifies the manipulation a little to add the acids all at once.

A careful manipulator may succeed in evaporating over the lamp direct until the sulphuric acid fumes strongly, especially if the material is stirred continuously, but after the sulphate of iron begins to separate there is much danger of loss by spirting. The air-bath is much more sure. When a number of determinations are carried on at the same time and there is no great hurry, excellent results may be obtained by adding the mixed acids to the borings, putting the casseroles at once on a steam plate whose temperature is about 275° F., and allowing them to stand without further manipulation over night. Where the air-bath and shorter time are employed, the casserole should be set down into the air-bath, below the line of the liquid inside. With the air-bath or on the steam plate, stirring is not essential.

It has been proposed to add Nordhausen sulphuric acid to the dish after the principal part of the nitric acid has been driven off, to get the strong sulphuric acid necessary to dehydrate the SiO_2 and thus to save the time required to concentrate the sulphuric acid to the proper point. Our experience with this modification is that the Nordhausen of the market is rarely pure enough to be trusted, while if Nordhausen is made by adding SO_3 to concentrated C. P. acid, there is considerable difficulty in the manipulation of the SO_3. That which comes in tin cans is very difficult to open and put into the strong sulphuric, without at the same time being contaminated, while if that in glass bulbs is used there is much danger that some of the glass of the bulb will get into the determination. The time and labor saved by this modification is not great.

It will be observed that directions are given to filter at once, after the iron salts are dissolved. Direct experiments following the manipulation given above show that after the water is added and the iron salts are in solution, if the material is allowed to stand before filtration 24, 36, or 48 hours, quite large amounts of the silica are redissolved and lost. This statement has been disputed, but our own experiments have been confirmed by other workers. It seems probable that a few hours' standing would make very little difference, but as there seems to be no good reason for dilution until one is ready to filter, we have not thought it worth while to study the cause of the discrepancy in the statements. The manipulation which we recommend is certainly the safer.

The use of half strength hydrochloric acid has been recommended to wash out iron salts. The experiments of some chemists seem to indicate that the silica obtained as above is perceptibly soluble in hydrochloric acid of this strength. As the iron salts seem to be completely removed by the more dilute acid, we prefer to use it as a precautionary measure.

If the dilution and washing have been managed with care, the silica obtained is generally perfectly white, and the residue after the treatment of hydrofluoric acid is very small. If there is a tint of iron oxide the residue will be larger. In no case should the hydrofluoric acid treatment be omitted when determining silicon in steel.

MASTER CAR-BUILDERS' CONVENTION.

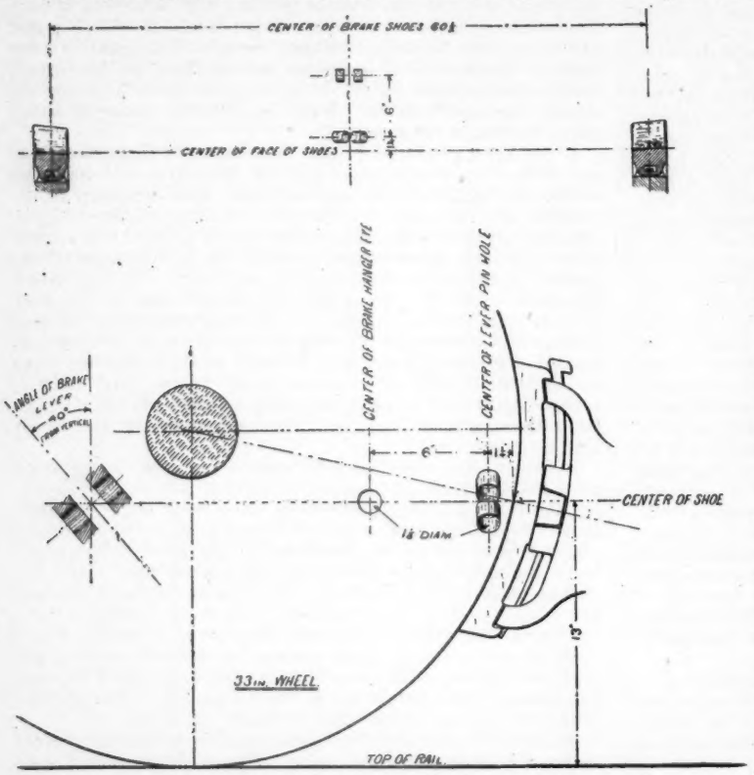
The twenty-eighth annual convention of the Master Car-Builders' Association was opened on the morning of June 12, at Saratoga, N. Y., with President Grieves, of the Baltimore & Ohio Railroad, in the chair. The preliminary business, including the President's address, Secretary's and Treasurer's reports, was transacted in the new convention hall. A *résumé* of the Secretary's report shows that there are now 326 members of the Association, including active, representative and associate members. The Treasurer's report showed that the expenditures made during the past year were $8,018.84, leaving a treasury deficit of $21.30. In the report of the Executive Committee a suggestion was made that the committee be empowered to bring the subject of the Master Car-Builders'

standards to the attention of the American Railway Association, and especially that of the rules of interchange, inasmuch as if these rules were sanctioned by the latter association they will probably be greatly strengthened.

After this brief introductory business the regular reports of the committees were taken up for consideration. The first offered was that on indelible pencils, the committee on which communicated with a number of manufacturers during July and August of last year, laying down the following requirements of the properties which a suitable indelible pencil should possess. They were these :

1. A clear black pencil, the writing of which cannot be erased by india-rubber or by other means without considerable trouble.
2. The material from which these pencils are made must retain its original conditions and must not become hardened or spoiled with age.
3. The pencils must be so that they can be readily sharpened and the leads not easily broken by clumsy-handed men.
4. The writing must not smudge or run if wet.
5. The writing must not fade by exposure to light.

After subjecting the pencils submitted to various tests similar to that of the regular use on interchange cards, and taking up in details the qualities of the various samples, the committee stated that they felt it possible for them to specially recommend pencils Nos. 13 and 14, American carbon pencil No. 113, American editor pencil No. 185 ; while pencil No. 12, Eagle No. 482, pencil No. 15, Dixon's leather and cloth marker No. 789, pencil No. 18, Dixon's marking pencil No. 784, pencil No. 19 and Faber's No. I, Unverwischlich, can all be considered as good pencils, filling the requirements fairly well.



PROPOSED DETAIL FOR BRAKE BEAM LOCATION.

The next paper offered was that on the standard sizes for catalogues, specifications, etc., of which Mr. Godfrey W. Rhodes was Chairman. It is unnecessary to reprint the whole of this report, but we give the sizes which were recommended for the Association's standard.

POSTAL CARD CIRCULARS.

1. 3¾ in. × 6½ in.

PAMPHLETS AND TRADE CATALOGUES.

2. 3½ in. × 6 in.
3. 6 in. × 9 in.
4. 9 in. × 12 in.

SPECIFICATIONS AND LETTER PAPER.

5. 8½ in. × 10⅝ in.

The reason for these recommendations is that the postal card circulars is that of the size ordinarily used ; that for pamphlets and trade catalogues allows the paper to be folded and cut economically without much waste from stock paper 35 in. × 37 in. The recommendations for specifications and letter paper was chosen, as it can be cut from folio sizes 17 in. × 22 in. The report then made recommendations in regard to a cheap file case for filing the papers of the above dimensions.

This report was followed by a report on steel-tired wheels, of which Mr. R. E. Marshall was the Chairman. From the replies received to its circulars from the members of the Association the following information was tabulated by the committee :

It seems to be the consensus of opinion that 1 in. is the proper limit of thickness for tires. On account, however, of the variety of sections of tires used, it is important that this limit be clearly defined ; and your committee, therefore, offers the following recommendations :

1. That the limit for thickness of tires of all steel-tired wheels shall be 1 in., measured normally to the tread and radially to the curved portions of the flange through the thinnest part within 4½ in. from the back of the flange—the thickness from the latter point to outer edge of tread to be not less than ½ in. at thinnest part. (See fig. 1.)
2. That, in order to facilitate inspection, a small groove shall be cut on outer edge of all tires at a radius ¼ in. less than that of the tread of tire when worn to the prescribed limit.
3. That the above recommendations shall be submitted to letter ballot for adoption as "recommended practice" of the Association.

The report was also accompanied by numerous engravings showing the methods of tire fastening adopted by all of the prominent wheel manufacturers in this country, as well as those of the Krupp and Arbel wheels, manufactured in Germany and France. These methods of fastening have been so repeatedly published that it is unnecessary for us to reprint them here. The report also includes tables giving the numbers of different makes of steel-tired wheels in use, with certain schedules of defects which have developed in the running of each wheel.

The committee having charge of the consideration of brake beams report that they found it impossible to give the dimensions for the location of the beam and brake relatively to the center line of the metal beam, and they therefore take as a starting point one which was absolutely fixed and had no reference whatever to a particular construction of beam. The line drawn horizontally and parallel to the truck and passing through the point of contact of the center of the standard Christie brake shoe with the tread of the wheel was found to fulfill these requirements. Inquiry showed that a standard distance of 60½ in. between the centers of brake shoes has been adopted by a very large proportion of the roads using a metal beam. This is also true of the adoption of the Master Car-Builders' standard lateral inclination of 40° for the brake lever. The committee therefore recommended that one standard height for both inside and outside beams should be adopted, and this is 13 in , measured from the top of the rail to the center of the brake shoe, as shown in the figure. The construction of trucks naturally renders it more difficult to get a standard height for inside-hung beams than it is for those hung upon the outside. If, however, the Association should consider that there should be one height for inside and another for outside beams, a recommendation of 14½ in. for the outside and 13 in. for the inside was made.

In the discussion which followed, Mr. West called attention to the advantage of the outside hung beam, in that when an automatic coupler falls down it will strike inside brakes hung at a height of 13 in., whereas it would be cleared by the higher outside beams.

The report on safety chains for freight cars may be reduced to a recommendation on the part of the committee that they are necessary only on flat and low side gondola cars, which are frequently used as twins and triplets to carry lading, extending over two or three cars, and the committee did not recommend the general use of safety chains on any classes of cars but with a view of securing interchangeability with any that might be applied, recommended a chain located 27 in. from the center of the car on either side, made of 1½-in. iron, secured by eye-bolts 1⅜ in. in diameter passing through the end sills, with a 4-in. hook on the left-hand side as you face the car, and the

end link of the other being of 1¼-in. iron; the inside hook to extend 6¼ in. beyond the inside face of the knuckle and the link of the corresponding chain to extend 5¼ in. outside this same point, leaving a slack of 11½ in to compensate for curvatures. The general impression conveyed by the discussion was that safety chains were not only unnecessary, but it would be rendered useless by the neglect of trainmen to hook them.

Mr. Waite, of the Lake Shore Road, called attention to the general practice of his road of chaining cars together where long structural iron or telegraph poles were being transported on two or more cars. On their passenger equipment the safety chains are placed 14½ in. from the center. This report was the last one read on the session of the first day, and the next one opened on the morning of the 13th with the reading of the report of wheel and flange gauges, which will be dealt with fully in a future issue of this paper.

After this discussion, the time of the convention was occupied by the report of the Arbitration Committee on the proposed amendments to the Rules of Interchange.

Thursday morning's session was opened by a continuation of the discussion of the Rules of Interchange, and before the session closed the reports on road tests of brake shoes was submitted, which is merely a report of progress and quite in line with the editorial paragraph commenting on the probable work of this committee in our issue for June. It is expected, however, that the tests will be completed within three months and that the report will be made out as soon thereafter as possible.

The report of laboratory tests of brake shoes gave a *résumé* of the work which has been done by Morin and Poiree, in France, and by Captain Douglass Galton, in 1878, in England The report also included tests of the Pennsylvania Road, made in 1891 and 1892, and had an appendix in the shape of a description of the brake-shoe testing appliance that has already been published.

On Friday morning the first report read was that on the lubrication of cars, from which we make the following abstract:

LUBRICATION OF CARS.

The committee opened their report by a discussion of the relative care which is given to locomotives and cars, and reported that there was quite a general lack of information as to the best means of securing proper car lubrication. The grades of oil in use on American cars vary from a very cheap crude oil at 5 cents to the best refined Galena oil at 35 cents per gall. Twenty-one of the roads replying are using Galena oil, while 17 roads use common West Virginia or black oil, and eight roads use either special oils or else part Galena and part common black oil.

From the replies received we find that the cost of oiling cars per 1,000 miles varies from 6 cents to $41\frac{6}{10}$ cents on passenger equipment, and from 6 cents to $26\frac{3}{10}$ on freight cars.

We find that 21 out of 45 roads use special cooling compounds to prevent or reduce hot boxes, in addition to the regular oil lubricant. A singular but significant fact is noticed, that with but four exceptions the use of special cooling compounds is confined to the roads using the cheap grade of oils, such as common black or West Virginia. It seems that of the 25 roads who find no need for a special cooling mixture, that 21 of them are those who use only the high grade Galena oil. This would seem to indicate clearly that the high grade of oils are better lubricators and need no expensive assistants in the shape of cooling mixtures. This suggests to your committee that in figuring on the comparative economy of different grades of oils, the feature of there being no necessity for a special cooler for use of trainmen and inspectors should be fully recognized.

From the 21 roads using special cooling mixtures, 2 roads report poor results, 7 fair results, 11 good, and 1 very good. It can safely be said in this connection that there are undoubtedly many cases of hot boxes occurring to-day that can be partially or wholly remedied by these special coolers judiciously used, but your committee firmly believe that many, if not most of these cars could be equally well cared for by the use of trainmen or inspectors of a proper quantity of freshly soaked waste and oil, carefully applied, the poor and dirty waste in the box being first removed. We further believe that by proper care being taken, in connection with various important points, which will be referred to later, that few if any hot boxes need occur.

The record of hot boxes per 1,000 miles on passenger equipment, as reported, shows quite a variation, running from .001 to .19, the average being .0516; or, in other words, the best record was one hot box in 1,000,000 miles run, while the poorest had one in about every 5,360 miles run, the average being one in about every 20,000 miles. A curious fact is shown by the reports—namely, that the three roads showing the best records and the three showing the poorest, all are using the highest grades, and consequently the highest-priced oils. This fact shows quite clearly that, though the best results can only be obtained by the use of the best grades of oil, poor results may be had with the same oil where insufficient attention is paid to other important features; or, in other words, the quality of lubricant is only one of the many details that must be looked after in the successful lubrication and cool running of car journals.

Another very curious development is the large variation in the number of gallons of oil used to the thousand miles run. This runs, on passenger equipment, as high as 4½ galls. and as low as $\frac{6}{10}$ of a gallon, the latter figure being on a short road with but few trains, which runs through a territory free from sand. Most roads in oiling passenger equipment use from 1 to 2 galls. per car per 1,000 miles run. The great variation will account readily for the well-oiled ties on some lines, and the wheels so often found thickly coated with grease and dirt. There is undoubtedly room for greater economy and much improvement by more careful supervision of car oiling.

In the oiling of freight equipment a similarly large variation in practice is noticed from the replies received. The minimum amount of oil used is slightly less than ¼ of a gallon per 1,000 miles, while the maximum is 2½ gallons.

Your committee feel warranted in recommending a good grade of all-wool waste, which is free from dirt, and is composed of good long fiber, as the best material for packing that can be obtained. The data at hand does not warrant giving any reliable conclusions as to the comparative efficiency and economy of cotton waste and elastic wool.

The opinions of roads with regard to the comparative freedom from heating of iron and steel axles seem to be about equally divided, and about all that can be said is that probably steel axles are freer from flaws and seams in journals than iron, and for that reason heat less from those causes. But, on the other hand, the grain of steel axles being much closer than in iron, there is less opportunity for the oil to be held in the minute spaces between the molecules of metal, and, as a consequence, is somewhat more difficult to lubricate steel journals, if they are loaded to anywhere near their full capacity.

The subject of proper mixtures and metals for journal bearings, and the kind and quality of metal for linings, is one which the replies to inquiries show to be in a very undecided state. There seems to be no uniformity of opinion on any kind of metal or any proportions of mixtures. On a few points as to journal bearings there is almost entire unanimity. All but two out of 46 roads favor a solid lead-lined journal bearing. Some of those so deciding are to a slight extent using filled shell bearings. All roads agree that the journal bearings should be ground or bored, and lined, on a radius larger at least by $\frac{1}{32}$ in. than the journal they are to run on. Some roads wish this to be as much as $\frac{3}{16}$ in larger. It is astonishing to find a few roads who neither bore nor grind their journal bearings, but simply clean the surface of the bearing and coat them with $\frac{1}{16}$ to $\frac{3}{16}$ in. of lead or babbit, and then are surprised when the lining is worn through that the hard, sand-lined surface of the bearing should begin to cause heating and cutting of the journal. No worse or more dangerous practice has come to the notice of your committee than allowing practically a rough unfinished casting to be used on a nicely polished journal to carry the weight of a heavy passenger coach, or sleeper, moving at from 40 to 60 miles an hour, with its freight of human lives who might be instantly killed or maimed by the excessive heating and consequent breaking off of a journal. Your committee hope that every member of this Association will discountenance such a dangerous and expensive practice, as trying to avoid the slight cost of properly boring new journal bearings at the possible and probable risk and cost of hot boxes, cut and broken journals, and possible wrecks with their attendant losses.

The information received by the committee indicates the almost universal use of lead, or lead with a very small percentage of antimony, as the best metal for lining bearings.

Wool has greater elasticity and retains it much longer, although it does not absorb and feed the oil quite so quickly as cotton. Oftentimes some of your committee have seen car-oilers or trainmen, and repairers, repacking or partially repacking boxes with dry waste, over which an excessive amount of oil has to be poured to give it the appearance of being properly packed. Such practice has done incalculable injury, and cannot be too strongly discountenanced. It should be a universal rule, which ought to stand in writing in every railroad shop, that all waste must be soaked in oil, being well covered, for at least 24 hours before being used; if possible it

should have 48 hours for the oil to act on it. In order that waste so saturated may not be used with more oil than it will properly hold, before using it should be drained from any surplus by being placed on a screen placed so the drainings will drip on to the still soaking waste beneath.

Experience has shown to us the fact that some of the most serious difficulties due to journal bearings have not been due to varying proportions of the different constituent metals, but rather to mechanical defects. It is an open question if it is not better to hold to the curved top bearing, with its few cases of hollow journals, than to make the bearing straight, thereby changing the standard and having more or less hot boxes in consequence. The committee deem it wise to recommend to the consideration of the Association the changing of the present standard $3\frac{1}{2} \times 7$ journal bearing and key to the form given to the $4\frac{1}{4} \times 8$ bearing and key—namely, make the top of the bearing straight and curve the top of key instead of the opposite, as it now is. This change could be made without interfering with interchangeability of parts, and in a few years all cars would be changed, with the benefits accruing yearly to each car changed. We would also recommend that all Master Car-Builders' journal bearings and keys made or purchased be required to pass the inspection and test of the gauges shown in fig. 2.

The committee also recommended certain gauges to be used in connection with the sizes of brasses and wedges, so that the fitting would be properly done.

Before concluding this report, your committee have one rather radical recommendation to make—namely, that for the best results to be obtained in line of good lubrication of cars and freedom from hot boxes, oil cans and clear oil should be once and for all removed from and forbidden to be used in shops, shop yards, and by train crews. Clear oil to be used only to a limited extent in interchange inspection yards. The reason for our recommendation is that most cases of heating of journals come from the waste sagging away from the journal, and therefore no oil is fed to it. If oil is poured on in such a case it only lubricates for a few minutes, for the oil still cannot feed on to the journal; but if instead of oil the dope bucket is used a small quantity of freshly soaked waste will furnish the necessary oil and will at the same time fill the box with waste up close around the journal, allowing the remaining oil in the balance of the waste to feed to the journal. If at shops all cars are freshly packed with saturated waste, or the box is properly filled with such, there is surely no necessity for the oil then. The use of waste in this matter will save much in the needless waste of oil, as well as put the oil boxes in the best condition for good service.

This was followed by the report on freight car brakes, in which the committee gave a detailed statement of the replies which were given to the nineteen questions sent out in their circular of inquiry From these replies it is seen that a large majority of car-builders were in favor of a 5 ft. wheel base, and in accordance therewith that base was the subject of a recommendation on the part of the committee. The committee also recommended that the size of arch bars be made 4 in. $\times$ $1\frac{1}{2}$ in. at top, 4 in. $\times$ 1 in. at the bottom, with a tie bar of 4 in. $\times$ $\frac{5}{8}$ in. No recommendation was made of special designs for arch bars, as there was no uniformity in this particular.

In the report of steam heating, the same methods were followed as in the preceding report. There were, however, twenty-nine questions instead of nineteen. From these it is seen that there are at present 5,869 passenger cars equipped with steam-heating apparatus or other improved methods and 6,432 cars not equipped. This represents a mileage of 30,011 miles.

The committee also received answers from 13 roads representing 16,947 miles and 2,414 cars which have not adopted steam heat, making a grand total of 5,869 cars equipped and 8,846 not equipped.

The report on air-brake and hand-brake apparatus on cars resulted in the showing on the part of the committee that the hand-brake apparatus as usually applied to the passenger coaches was inadequate to give a full brake pressure on the wheels on account of the lack of leverage obtained with the small hand wheels in use. These latter were frequently placed so close to the center of the car that when coupled with the vestibule they were inoperative. The greater portion of the report, however, was taken up with a discussion of air-brake apparatus and its proper maintenance, the committee urging that greater care should be taken in the inspection and better arrangements be made in order that this inspection might be thoroughly done. It showed that very few roads were equipped with adequate facilities for doing this, and then gave a detailed description of a large plant wherein the yards and shops were so piped that inspection and adjustment of the air-brake apparatus was possible at all points. In some cases repairs had better be made by supplying new parts, such as defective triple, which could be removed and replaced in fifteen minutes and had been done in seven. In regard to the defects noticed at interchange points, there is one which has attracted considerable attention, namely, that of the cutting of coupling gaskets. In an effort to keep the apparatus clean many companies are endeavoring to enforce the hanging up of the hose. When this is improperly done the bent hose becomes a receiving basin for flying dust and cinders, in which case it would be preferable to let it hang down. The hook on the dummy coupling is also very frequently inserted inside the gasket, with the result that the usefulness of the latter is destroyed in a short time. The remedy suggested by the Central Railway Club was endorsed by the committee. It consisted of the enlargement of the point of the hook on the present dummy coupler, which will prevent its improper use, thus ensuring freedom from damaging contact with the gasket and exclusion of dirt whenever the coupling is hung up.

The Committee on Car Ventilation summarizes the ideal conditions of the same in ten paragraphs which would be very difficult to realize. These were:

1. The admission of 30 cub. ft. per minute per passenger of fresh air and the carrying off of an equal amount of foul air summer and winter.

2. The fresh air so admitted must not be moving at a speed of more than three or four miles per hour in winter time.

3. Fresh air admitted must be at a temperature in winter time of about 70° F.

4. Fresh air so admitted in winter time must have added to it a proper degree of moisture for the temperature at which it is admitted, according to the average humidity of the atmosphere when at 70° in the climate in which the cars are running.

5. No system of winter ventilation can be successful unless means for the fresh-air supply are provided independently of and separately from the windows and doors as well as the ventilators for carrying off the foul air.

6. The fresh warm air should be distributed through as many openings and as low down as it can be conveniently arranged for, and the foul air should be carried off through as many small openings in the roof of the car as can conveniently be arranged for in winter.

7. The ventilation should be entirely independent of the speed of the train and act equally as well whether the car is standing or running.

8. The ventilation should be so arranged that there will be a plenum or slight excess of pressure inside the car, so that all drafts will be outward instead of inward, and smoke and dust thus excluded.

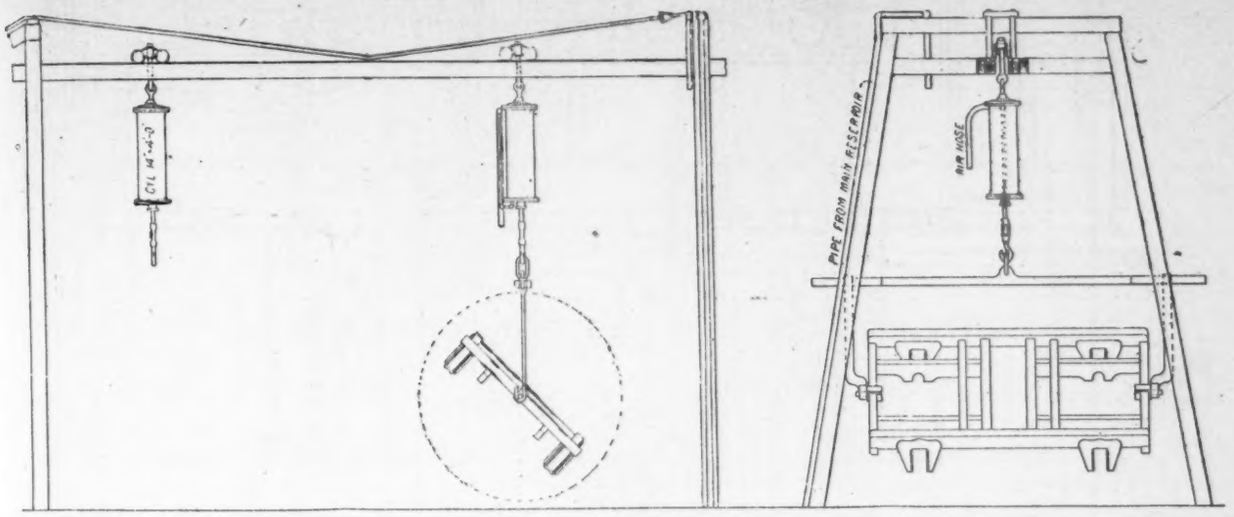
9. It is most desirable that double windows should be used, and so arranged that they can be locked fast in winter time, but readily opened in summer time.

10. It is most desirable that an inside swinging door be used, so as to form an air lock or inside vestibule, to prevent the admission of cold air and dust every time the doors to the platform are opened.

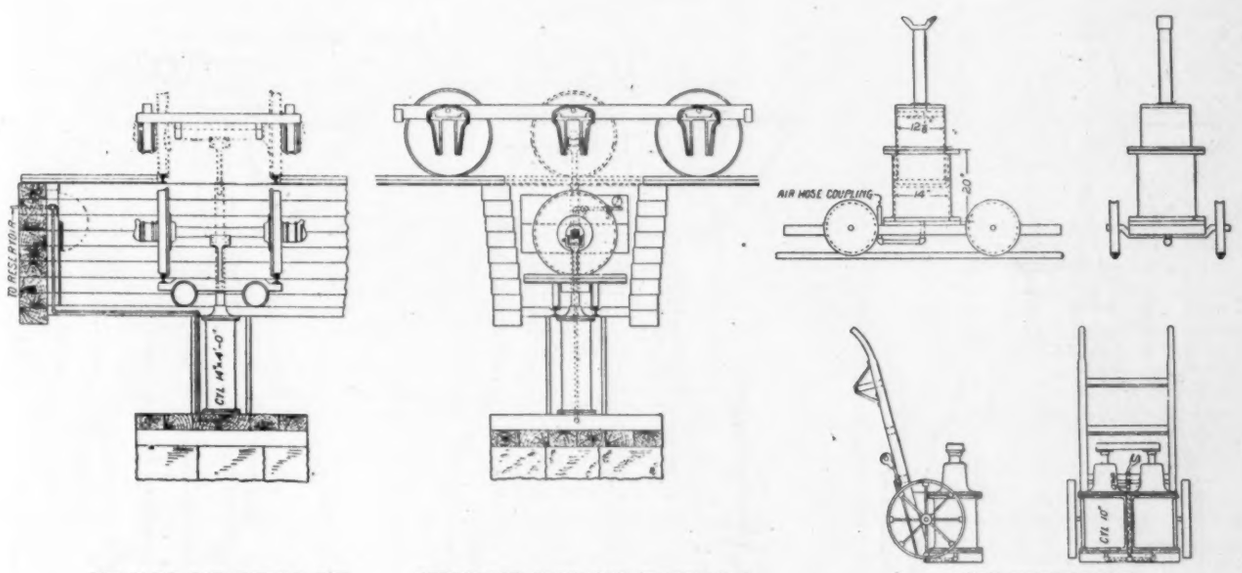
These conditions were followed by a discussion of the unhealthfulness of apartments containing more than four parts in 10,000 of carbonic acid gas, and also by tables showing the conditions of air in sleeping cars, the shop yard at Aurora, Ill., chair cars, suburban coaches, and a few miscellaneous tests. These average as follows: Sleeping cars, .18; shop yard, .04975; chair cars, .10725; suburban coaches, .1375. The miscellaneous tests were: For an office occupied by six persons, with a door to the hall on a cold day, .085; the opera house in rear of floor seats, house full, .143; chemical laboratory, two persons and two lamps burning, .040.

This shows that the air of sleeping cars is the most impure that was encountered by the committee making the investigation, and that the purest air was in the laboratory occupied by two persons with two lamps burning, even more so than that of the shop yard, which was probably contaminated to a greater or less extent by the gases from furnaces and locomotives; but when we take into consideration the fact that there was more than four times as much carbonic acid in the air of the sleeping car as there was in the laboratory, it is readily understood why there is so much complaint of sleeping car ventilation and why there are so many headaches in the morning after a night's travel.

The Committee on Compressed-Air Appliances and Hydraulic Machinery sent out a circular of inquiry, and the answers received thereto showed that compressed air was used in car shops and yards for a great variety of purposes, such as jacks for lifting and lowering freight cars, drop pits for removing and placing car-wheels in trucks under all classes of passenger equipment, pneumatic portable jacks for lifting

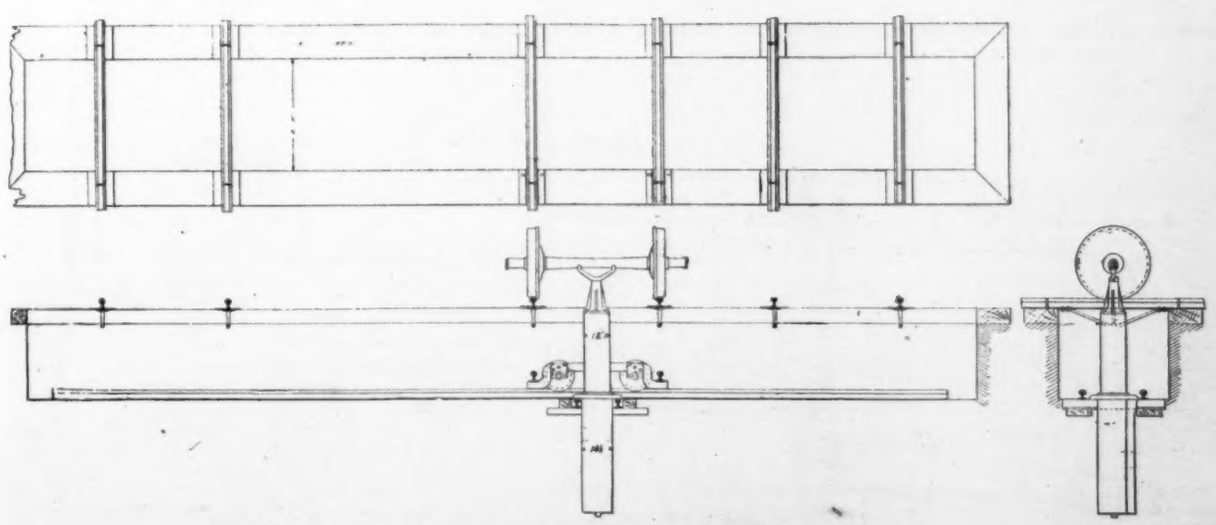


HOIST FOR LOADING AND UNLOADING CARS. TRUCK SHOP HOIST FOR LIFTING AND TURNING OVER TRUCKS. LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

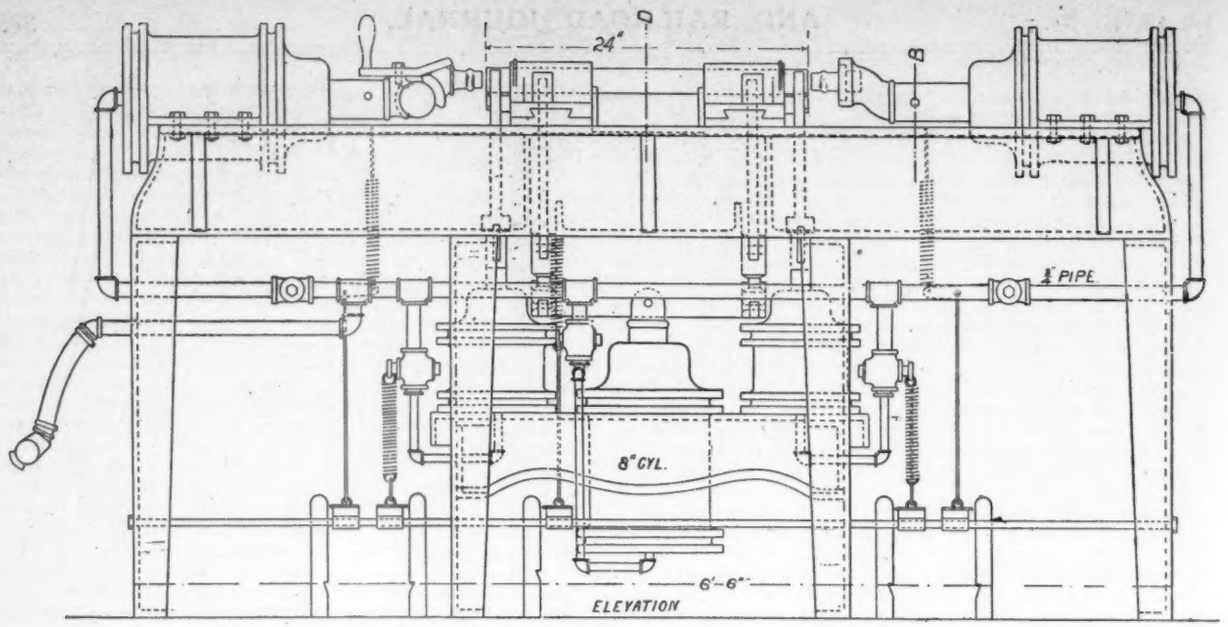


PIT JACK FOR WHEEL PIT. TELESCOPE JACK FOR WHEEL PIT. SHOP TRUCK JACK.

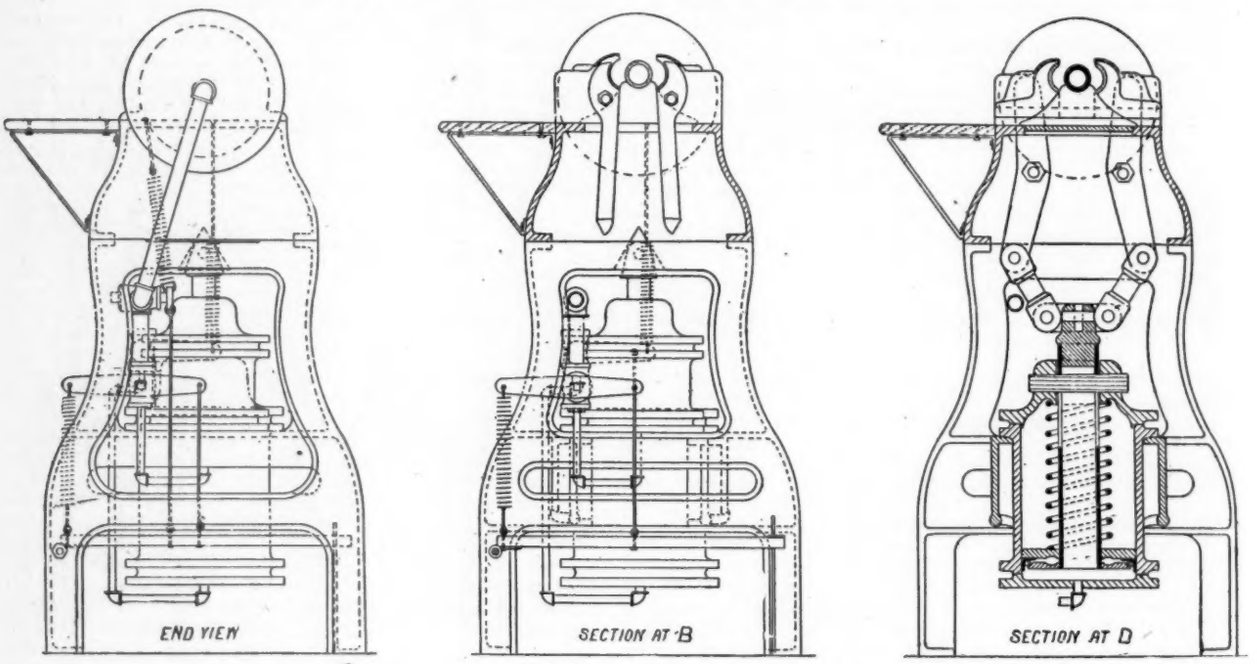
LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



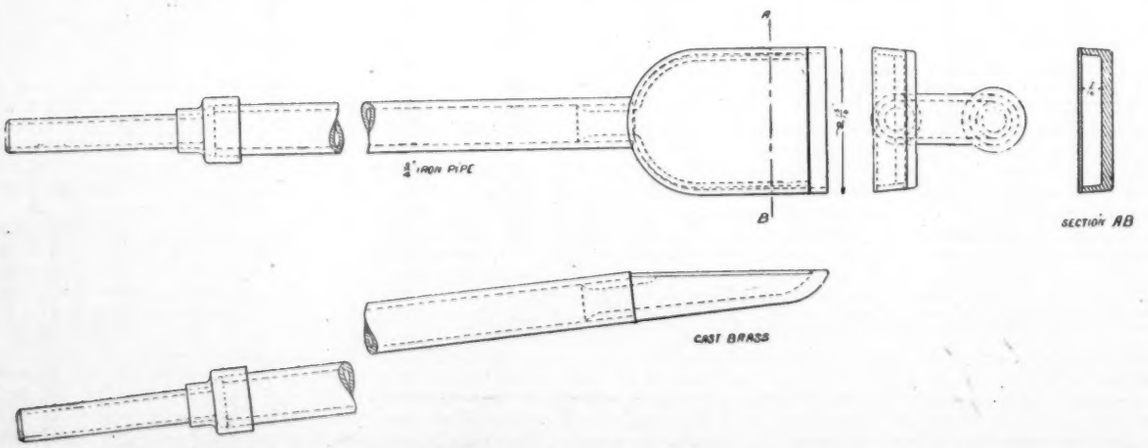
PASSENGER TRUCK DROP PIT, CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.



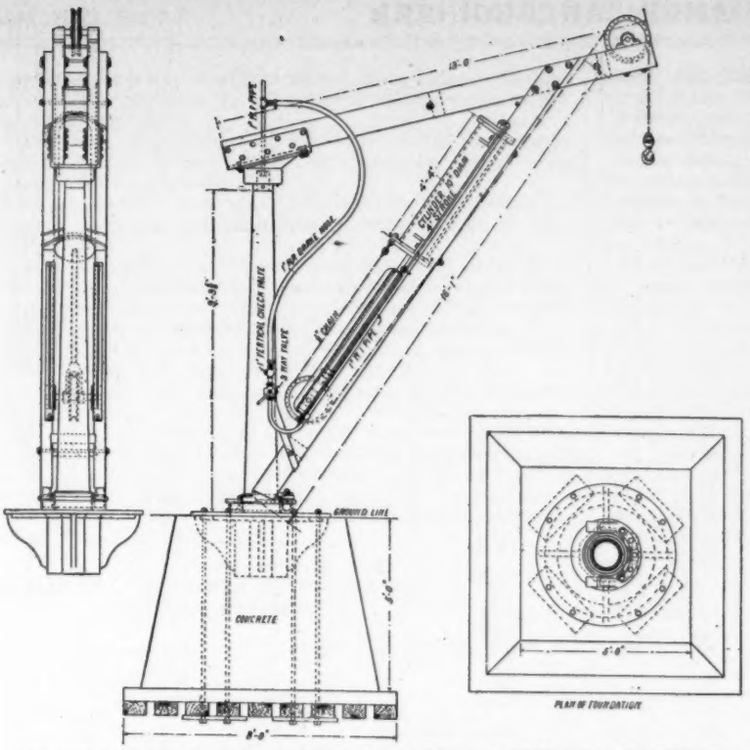
MACHINE FOR APPLYING AIR-HOSE FITTINGS, NORTHERN PACIFIC RAILWAY.



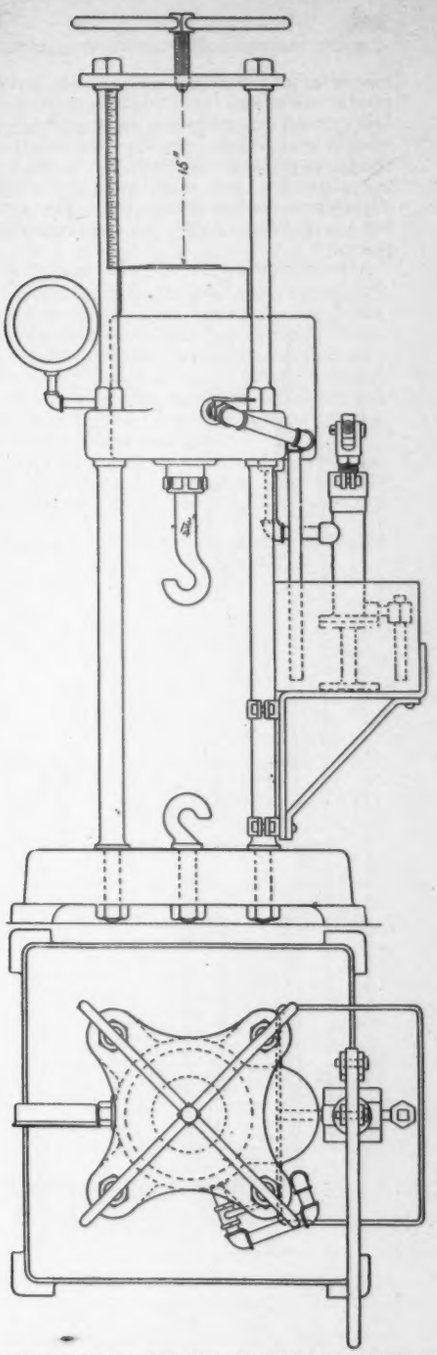
MACHINE FOR APPLYING AIR-HOSE FITTINGS, NORTHERN PACIFIC RAILWAY.



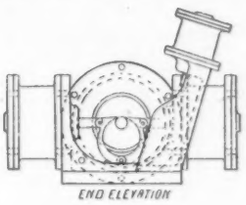
AIR-DUSTER NOZZLE, CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY.

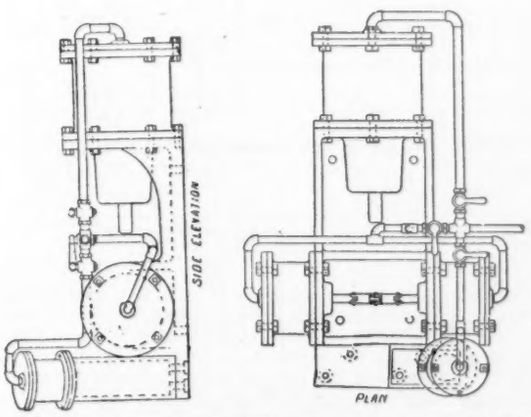


AIR HOIST FOR LOADING WHEELS AND AXLES, CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY.

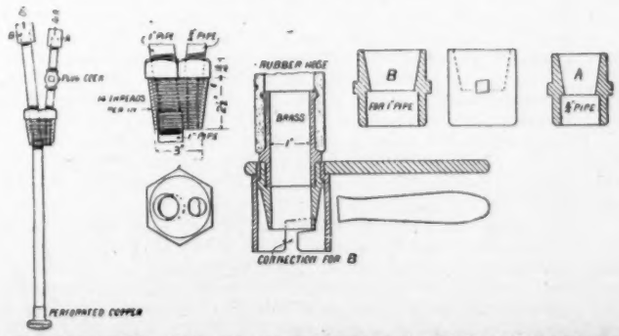


HYDROSTATIC TESTING MACHINE, NORTHERN PACIFIC RAILWAY.

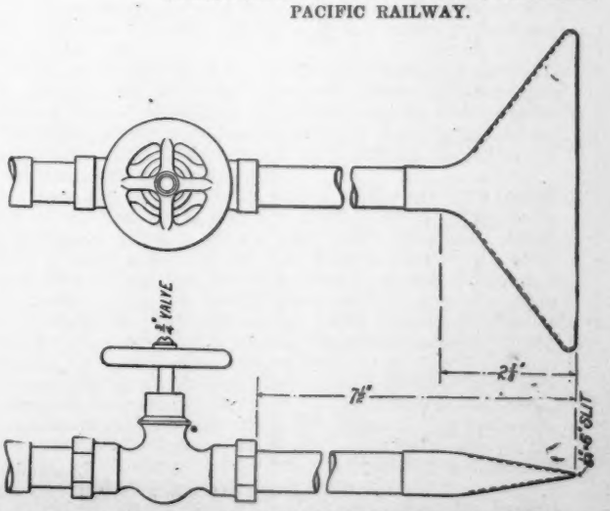




PLAN FOR APPLYING HOSE CONNECTIONS. NEW YORK, PENNSYLVANIA & OHIO RAILROAD.



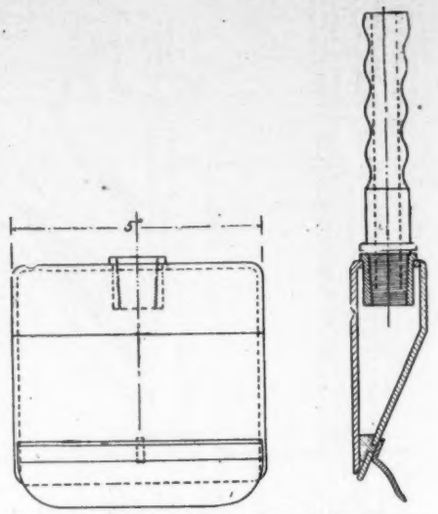
ARRANGEMENTS FOR TRANSFERRING OIL FROM OIL BARRELS TO TANKS IN OIL HOUSE, NEW YORK, LAKE ERIE & WESTERN R. R.



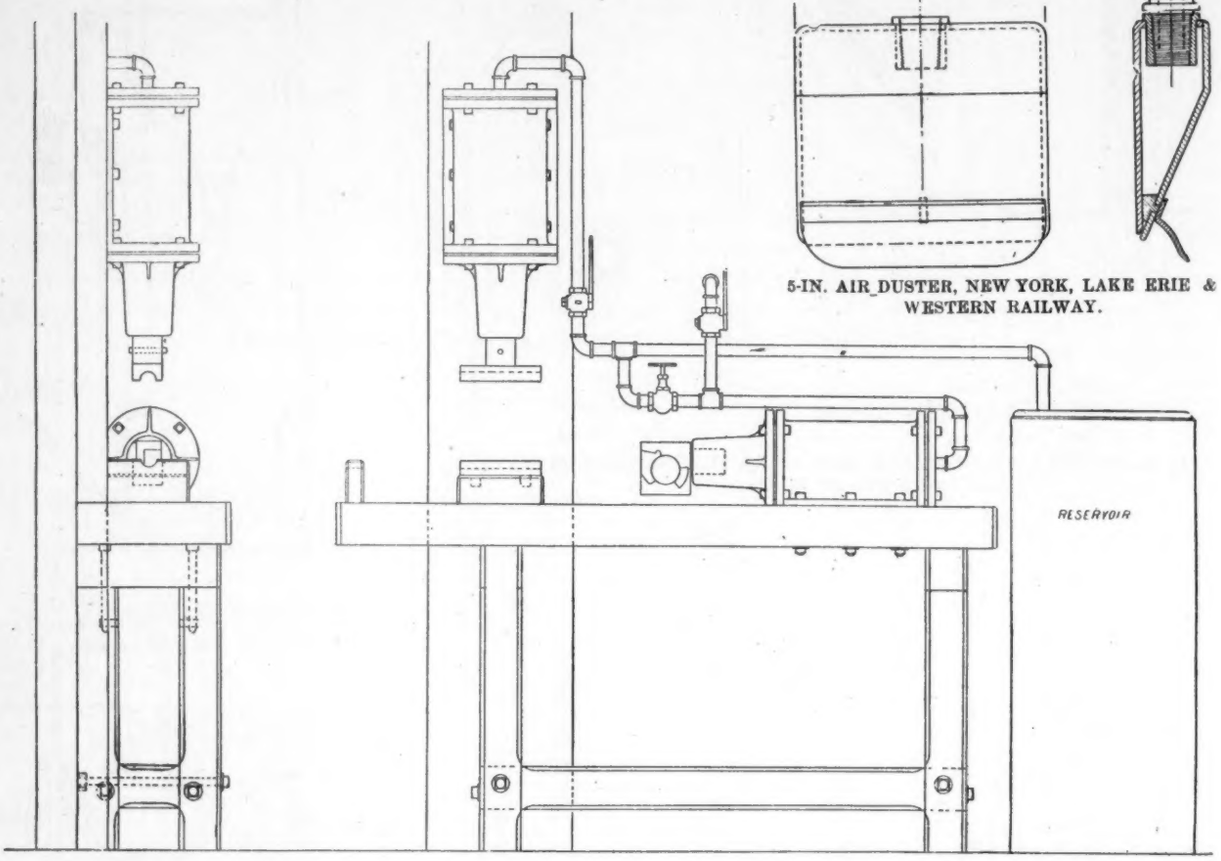
AIR-DUSTER NOZZLE, CHICAGO, ROCK ISLAND & PACIFIC R. R.

couplers into position, pull-down jacks for defective sills, needle beams and body bolsters, putting couplers on air-brake hose, cleaning cushions, upholstery, carpets, etc., loading wheels and axles, lifts for machine tools, operating drills, rivets, transferring oil from the barrel to tanks, punches, testing air-brakes and sand-blasts for applying satin finish on silverware, car trimmings, etc. The usual method of obtaining the pressure is by the employment of a locomotive air-pump.

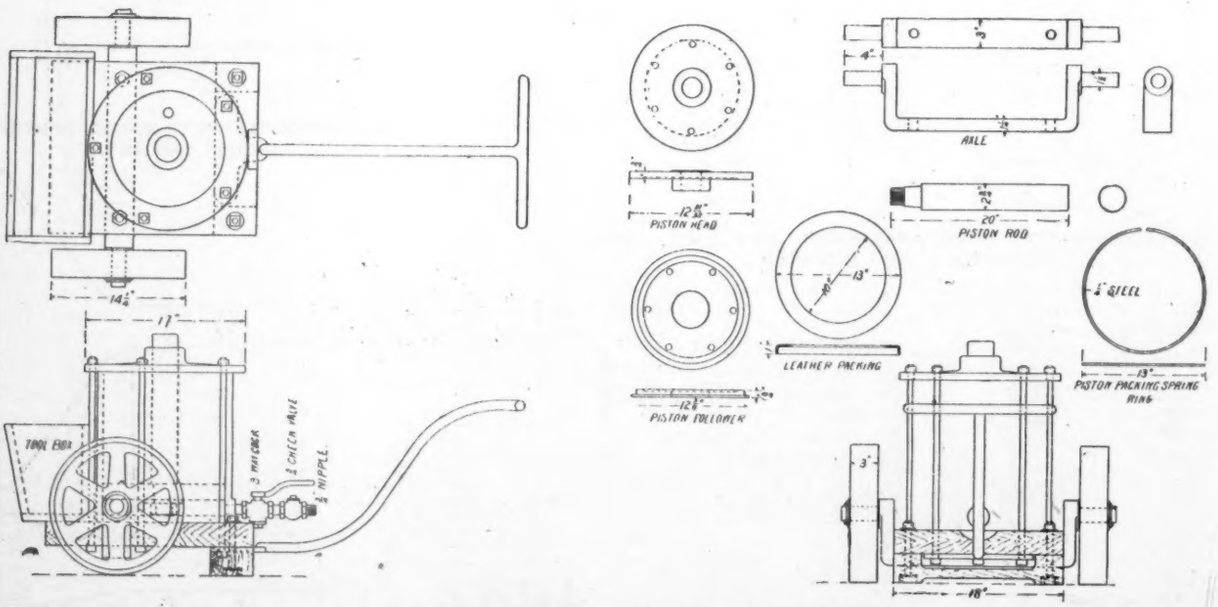
After reviewing the general conditions which must be ob-



5-IN. AIR DUSTER, NEW YORK, LAKE ERIE & WESTERN RAILWAY.



PNEUMATIC HOSE MACHINE FOR APPLYING HOSE COUPLINGS, ST. LOUIS SOUTHWESTERN RAILWAY.



13-INCH PNEUMATIC JACK, NORTHERN PACIFIC RAILWAY.

served in the application of compressed air to shop appliances, the committee recommends a few points to be observed when establishing air plants.

1. Arrange for the admission of cool air into the compressor, as the cooler the air can be taken in, the greater the economy in the cost of compressing.

2. Clean air, free from disagreeable odors, is desirable for cleaning purposes, and should be provided for at air-compressing plant.

3. It is advisable that the storage reservoir be placed at no great distance from the compressor, the principal reason being to lessen the liability of yard pipes freezing in cold weather. Proper provision should be made for drainage of pipes.

4. All pipes for conveying the air should be of sufficient size to prevent loss through friction, bearing in mind that they cannot be too large, as the volume of air contained therein represents that much increase in storage capacity.

5. To prevent moisture, dirt, and oil from passing into the air-using appliances, the inlet and outlet of compressed air in the storage reservoir should be separated as far as possible, and connection applied near top of reservoir, and a drainage plug provided at bottom for purpose of draining off accumulations of water, oil, etc.

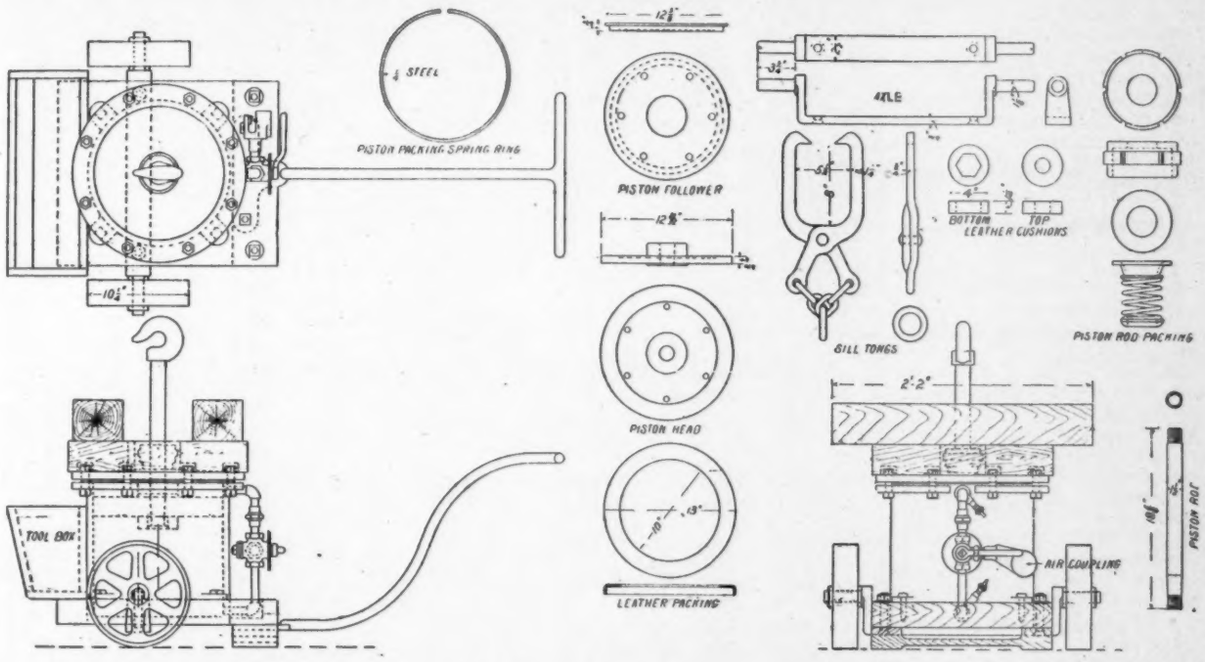
which we estimate would have taken the same labor from 30 minutes to 1 hour to have removed.

Several members report using pneumatic jacks for lifting and lowering purposes in car shops and repair yards, operated by a line of pipe leading from air reservoir, and located convenient to tracks, from which a hose connection to jack furnishes the air pressure required, and all report great economy resulting from their use over the present common screw and hydraulic hand jacks, a saving in some cases of 51¼ per cent.

Special attention is invited to the air appliances for applying fittings to air-brake and steam hose, especially machines similar to the one in use on the New York, Lake Erie & Western Railway, which is reported to your committee as performing the work it would take eight men to do by hand. Several other well-designed machines of this nature were described and reported as productive of great economy. Investigating these machines further, your committee finds:

1. You can use up all the rusty couplings, and you can apply an old coupling as easily as a new one. By hand it would be almost impossible to get an old coupling into some of the air hose.

2. It admits of having air hose made so that it will take



PULL-DOWN JACK FOR REMOVING CAR SILLS, NEEDLE BEAMS AND BOLSTERS, NORTHERN PACIFIC RAILWAY.

Explaining the value of compressed-air appliances, mentioned herein, it is reported to your committee that the pneumatic jacks or drop pits corresponding to those of the Lake Shore & Michigan Southern, and Chicago, Rock Island & Pacific Railway companies (as shown in cuts herewith) effect a saving of 47½ per cent. in the work of changing wheels in passenger-car trucks. The devices for cleaning car cushions by air, shown by actual tests made by the committee, result in a very large saving. The average time consumed by two men (one operating a 5½ cleaning nozzle, the other handling seats) in removing the dust from plush and springs of 200 seats, making them absolutely clean, was from 27 to 33 seconds to each seat. The air used in this test was supplied from a reservoir, and varied from 90 to 60 lbs. pressure. A similar test at cleaning by hand with common rattan beaters and brushing process by two men consumed from three to four minutes to each seat, effecting a saving of time in favor of cleaning by compressed air of 85 per cent.

The committee witnessed a test with pneumatic pulling-down jack in pulling down defective oak center sill from freight cars where the vertical bolts securing the same had become corroded, and would not yield to the blows of a heavy sledge-hammer. The pneumatic pulling-down was placed in position in two minutes, and sill pulled entirely loose at one end in 40 seconds; the machine was again reset in two minutes, and the other end of sill removed in 30 seconds, making 5 minutes and 10 seconds to remove center sill by two men, from 20 to 30 lbs. pressure to apply couplings, and by so doing you do not require to depend so much on the band or clamp for securing hose on coupling, thereby reducing the liability of hose blowing off of coupling when in service, causing delay, etc.

3. With one or two of these machines located at convenient points on a system, all of the hose can be fitted up where machines are located, which would concentrate the stock, consequently doing away with the necessity of other repair points carrying this material, effecting a large saving on account of not accumulating a surplus stock.

The novel and satisfactory feature of whitewashing a roundhouse, as reported by the Chicago, Burlington & Quincy Railroad Company, and one or two other roads, by placing liquid lime in a small reservoir and charging the same with compressed air and applying the whitewash by means of hose and spray nozzle, we believe could be successfully employed with saving results for rough structures about a car-shop plant or yards, and the subject is worthy the consideration of the members.

It was reported by the manufacturers of air appliances that superheated compressed air used in air lifts, jacks, engines, etc., increases the efficiency fully 50 per cent., but your committee was unable to make test or procure reliable data on the statement which would be of value in deciding the question as to cost, feasibility, and economy in its use.

A large number of compressed-air appliances are located

LOCOMOTIVE RETURNS FOR THE MONTH OF MARCH, 1894.

Name of Road.	Number of Serviceable Locomotives on Road	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains	Service and Switching.	Total	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	844	758				1,976,707	2,608						87.68			5.21	7.69	0.20	0.22	6.61	1.55	21.48			1.69
Canadian Pacific	603		492,906	652,095	258,906	1,403,907	2,328						72.89			5.19	11.05	0.35		5.75	1.45	23.79			3.03
Chic., Burlington & Quincy	541					1,385,098	2,560	4.72	19.15				86.78			5.05	5.93	0.20	0.24	6.82	0.04	18.28			1.32
Chic., Milwaukee & St. Paul	865					2,001,056	2,340						73.61			4.11	7.18	0.28		6 91		18.48			2.38
Chic., Rock Island & Pacific	564		479,550	923,679	310.715	1,713,944	3,039	5.20	1.78	57.20	75.84	41.14	64.83	11.17	4.63	1.79	5.98	0.24		6.25	0.41	14.67			2.16
Chicago & Northwestern	1010		803,244	1,324,365	552,565	2,680,174	2,653						90.01			3.49	8.25	0.39		6.28	0.88	19.20			1.82
Cincinnati Southern																									
Cumberland & Penn.*	23	23	5 772	27,745		33,517	1,457						87.21			5.68	4 68	0.35			1.91	12.63			
Delaware, Lackawanna & W. Main L.	212	171	72,572	200,393	272,869	545,834	3.192						86.80			2.87	7.00	0.43		5.82		16.12			1.60
Morris & Essex Division	162		184,471	151.806	82,141	418 418	2,582						71.35			3.39	11.13	0 37		6.34		21.23			3.09
Hannibal & St. Joseph	67	67				237,259	3,650	4.60	17.13				83.09	13 63	6.65	3.46	5.40	0.11	0.35	7.03	0.02	16 37			1.38
Kansas City Ft. S. & Memphis	145		94 378	218,982	86,769	400.129	2,759						68.59			2.97	5 37	0.23	0.41	7.39		16.37			1.52
Kan. City, Mem. & Birm	42	37	35,536	52,537	11,606	99,679	2,694						67.98			3.63	3.90	0 26	0.32	7.04		15.15			1.08
Kan. City, St. Jo. & Council Bluffs	37	37				131,655	3,558	4.87	23.12				74.07	14.36	4.60	3.00	7.11	0.18	0.68	6.80	0.02	17.79			1.90
Lake Shore & Mich Southern	592		429,568	833,812	400,709	1,664,089	3,157			60.44	93.10	38.84	71.33			2.93	5.24	0.05	0.12	6.77	0.15	15.26			1.46
Louisville & Nashville																									
Manhattan Elevated		296	777,741		69,489	847,230	2,862						43.39			2.30	8.70	0.20		9 00		20.20			3.99
Mexican Central	148	126				447,543	3,552						68.49			5.01	12.24	0.42		4.51	0.09	22.27			3.92
Minn., St. Paul & Sault Ste. Marie	104	78	78,610	132,726	22,696	234,032	20.000	4.96	20.17				76.86		5.18	4.26	12 93	0.25		6.55		23.99	4.09	1.39	3 33
Missouri Pacific	351					940,005	3,333	4.39	16.98				87.22			5.22	6.19	0.30	1.40	6 24	1.46	20 81	4.16	1.49	1.39
Mobile & Ohio	107	87	77,216	159,869	57,810	294,895	3,389						65.72			2.99	4.71	0.22	0.59	5.73	0.90	15.14			1.43
N. O. and Northeastern																									
N. Y., Lake Erie & Western	634	387	435.921	732,184	239,618	1,407.723	3,638	4.30	23.70	88.50	136.80	78.50	101.23	20.70	5.80	4.42	7.71	0.37	2 20	7.34	1.31	23.35			1.37
N. Y., N. H. & H., Old Colony Div			369,211	146,089	167,389	683,835		3.80	17.60				66.42	18.00	5.40	3.48	9.98	0.57		7.29	0.76	22.08			
N. Y., Pennsylvania & Ohio	274	157	127,702	366,911	117,686	612,299	3.899	5.20	19.70	69.30	111.90	143.55	108.25	13.40	5.70	4.49	5.02	0.31	2.52	7.00	1.15	20.49			1.04
Norfolk & Western, Gen. East. Div.†			93,834	283,938	50.911	428,683	2.713	4.92	21.24	50.50	126.40		88.45	10.20	5.90	5.39	3 61	0.31				9.31			3.30
General Western Division†			98,018	324,702	52,003	474,723	2,601	5.59	17.34	80.00	136.00		127.00	14 34	8 37	7.27	4.21	0.25				11.73			
Ohio and Mississippi																									
Philadelphia & Reading			429,677	305,231	752,999	1,487,907							82.67			4.83	4.59	0.26		5.73	0.47	15.88			
Southern Pacific, Pacific System	725	646	682,927	747,020	257,041	1,686,988	2,611	5.66	13.90				70.27			5.85	16.20	0.21	1.99	7.24	1.21	33.30			4.80
Union Pacific																									
Wabash	418	334	429,517	590,640	202,155	1,222,312	3.659	4.55	17.05	69.03	105.04	61.96	85.72	15.17	6.15	3.08	4.84	0.25		6.08	0.89	15.14	2.92	1.01	1.16
Wisconsin Central	149	94	116,409	163,802	45,425	325,636	3,464						81.10			2.60	9.25	0.15		7.08		19.08			2.25

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

out of doors under circumstances where water used in hydraulic machinery would not be economical to maintain on account of freezing, and the committee therefore decided that hydraulic machinery does not possess as many advantages for car repairs and construction purposes as compressed-air appliances. This part of the report occupies the first four pages, and the remaining 19 are used in illustrating the various pneumatic and hydraulic appliances, drawings of which were sent to the committee. Some of these drawings have already been published in THE AMERICAN ENGINEER AND RAILROAD JOURNAL. Among them we would cite the hydraulic lift used at the Oneonta shops of the Delaware & Hudson Canal Company, and published in our issue of April, 1893. The hydraulic-car lift is similar, except in a few unimportant details, to the locomotive lift published in July, 1893; the hydraulic wheel-crane published in April, 1893; the hydraulic jack for car shops, of December, 1893. In addition to these there was a 12 in. air hoist of the Chicago, Burlington & Quincy Railroad, and a similar one of the Minneapolis, St. Paul & Sault Ste. Marie Railway, which are in every respect similar in detail and construction to those published in our issue of February, 1894, illustrating the ones used at the shops of the New York, New Haven & Hartford Railroad, at New Haven, Conn.

The other appliances given in the report of the committee consisted of a hoist for loading and unloading cars of the Lake Shore & Michigan Southern Railway, a pit jack, telescope jack, and shop-truck jack of the same road; a passenger-car truck drop-pit of the Chicago, Rock Island & Pacific Railway; a pull-down jack for removing car cylinders of the Northern Pacific Railway; a 13 in. pneumatic truck jack on the same road; a pneumatic hose machine for applying hose couplings on the St. Louis & Southwestern Railway; 5-in. air duster nozzle of the New York, Lake Erie & Western; a similar nozzle of the Chicago, Rock Island & Pacific Railroad, and also an air duster of the Cleveland, Cincinnati, Chicago & St. Louis Railway. The plan for applying hose connections of the Pennsylvania & Ohio Railroad is also given, and the hose couplings for transferring oil from the oil barrel to the tanks and oil house of the New York, Lake Erie & Western; an air hoist for loading wheels and axles of the Cleveland, Cincinnati, Chicago & St. Louis Railway; a hydraulic testing machine of the Northern Pacific, and a machine for applying air hose fittings of the same road. These illustrations are reproduced herewith.

The committee on automatic coupler standards and limits made an elaborate report on the method of conducting the coupler tests both at the Watertown arsenal and at Altoona, giving data in regard to the shipping directions and general conditions of the test, which are already familiar to our readers. One feature, in addition to the direct tensile test which was made at Watertown, and the drop test as usually conducted at Altoona, is the newly introduced jerk test, in which an attempt was made to reproduce as nearly as possible the strains which are put upon a coupler in starting a heavy train, or such as will occur at sudden changes in the grade. In this test two draw-bars were used. They were inverted and placed in the machine together, suspended from pedestals by tail bolts and yokes and freight draft springs, allowing 1¼ in. between striking points, and held in position as arranged for in the construction of the machine. A weight of 1,640 lbs. was dropped on an equalizer bar connecting the two couplers. Three blows from a height of 5 ft. and three blows from a height of 10 ft., the blows being continued from a height of 15 ft. until the coupler was destroyed or rendered unserviceable. The results of these tests showed that 16 per cent. of the shanks cracked and broke behind the head, 26 per cent cracked and broke in the head and 44 per cent. of the knuckles were broken. In the opinion of the committee these tests should be considered as furnishing independent information from drop tests made on a solid foundation. It is acknowledged, however, that it is open to criticism as being artificial; but without it there would be little information obtainable as to the efficiency of locking devices.

The result of this test conflicts with the observation of service, for whereas in actual service there is a preponderance of guard arm failures, in the test the shank failures are in excess. The probable explanation is that direct blows concentrate the shock on the opposite side of shank, whereas a glancing blow or one from a broken link and pin coupler wedges off and breaks the guard arm alone.

The committee stated that before endorsing the recommendations made in the report of 1892, they would call attention to the necessity of the revision of the dimensions of the shank immediately behind the head, stating that while larger fillets would accomplish good results, they believed, at the same time, a more satisfactory design would be the widening of the shank for short distances together with the introduction of larger fillets. The committee have also called attention to the indifference displayed toward the M. C. B. contour lines. Out of 114 couplers presented, representing 25 different kinds, but 20 couplers fully complied with the M. C. B. limit gauges.

In regard to locking device your committee is at a loss to recommend anything that would be of value. It has been impossible to assimilate the many different types presented. This must be the work of future investigation. It has only to say that the results show that locking devices are efficient in proportion to their simplicity.

The committee hesitated in recommending the material to be used for couplers. The result shows that the strongest coupler, all other things being equal, will no doubt be made of steel. The worst steel bar, however, is not as good as the best malleable iron bar, although the best steel bar is superior to the best malleable iron bar, and the poorest steel bar is better than the poorest coupler made of malleable iron. It does not follow, however, that the use of malleable iron is to be condemned for the reason that your committee does not believe that strength alone is the all-important item. Few structures, involving expenditure of money, are designed to do more than is required of them with the proper safety factor. A coupler of steel or one of malleable iron may be made so heavy and so large as to be practically indestructible, and at the same time it would be neither cheap in first cost nor satisfactory to use. Future developments would seem to be in the line of making a coupler as light as possible, and sufficiently strong to meet the strains to which it is subjected, of as cheap material as is consistent with the above; and the coupler which will have the highest commercial value will be the one which combines the elements "minimum weight," "minimum first cost," "the greatest average strength," and "the most perfect yet simple action." In addition to this we must consider also the cost of renewals of couplers which have failed in service.

The Secretary of the Association made the report of lighting passenger car equipment on account of the fact that the committee were not prepared to render a report. His report consists of a compilation of statements from various roads which are using Pintsch gas, Frost light and electricity. Of these, ten roads and the Wagner and Pullman Palace Car Company report that they have either adopted the Pintsch light or are equipping cars with them as rapidly as possible. The Pullman Company report that it is a great saving in the matter of carpets and upholstery, as oil lamps leak more or less and injure them. The New York, Ontario & Western Road report that all cars that are being generally repaired are equipped with the Frost light; other roads do not mention at what rates the introduction of this light is being extended. Eight roads report having used electricity, but only two, the Pennsylvania and the Chicago, Milwaukee & St. Paul, are continuing its use, the others having abandoned it almost entirely on account of expense, and the Chicago, Milwaukee & St. Paul arrangements are those of an independent dynamo under the designs of Mr. Gibbs. With this system the cost of running light is estimated at $.88 per car per day when figured on a seven-car train; but if a longer train were taken the cost per car would be somewhat less as the allowance for attendance would be the same.

The final work of the convention was transacted on Friday morning with the continuation of a discussion on the interchange rules and the adoption of the other resolutions of thanking the various parties who had rendered courtesies to the members of the convention.

On Sunday evening a memorial service was held in the parlor of Congress Hall to Mr. Joseph K. Bole, of the American Steel Casting Company. A short tribute was read and resolutions of sympathy and appreciation passed. Similar resolutions were also adopted regarding Robert Ross, who was killed at the last city elections at Troy, N. Y., of Mr. Alfred Reed Slack and Major John C. Paul.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a

favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in May, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS FOR MAY.

Parnassus, Pa., May 3.—A collision occurred at Johnstown on the Allegheny Valley Railroad this morning, between a gravel train and an accommodation train. The engineer and fireman escaped with slight bruises.

Birmingham, Ala., May 6.—A south-bound freight on the Louisville & Nashville Railroad was wrecked at Wilhite this morning. Engineer William Whitman was instantly crushed to death, and his fireman, Joe Orr, seriously injured. The cause of the accident was that the freight train ran off the end of a stub switch, when the engine left the track and rolled down a 10-ft. embankment.

West Plains, Mo., May 7.—A freight train ran into a bunch of cattle near Brandsville this morning. The engine and six cars were derailed and wrecked. Engineer Kelsey jumped, but was caught by a car and was literally cut in two.

Tomsville, Ky., May 8.—George Patrick, an engineer on the Louisville & Nashville Railroad, committed suicide to-day on account of an accident to his train about a month ago. The engine collided with another on account of an order he had forgotten, and slight damage was done to both locomotives; no one was injured. He had been in the railroad service for 40 years, and this was his first accident. He was dismissed on account of being considered untrustworthy, and became so worried over it that his mind was unbalanced.

Gilman, Ill., May 9.—A northern express on the Illinois Central Railroad was wrecked at Buckley, 9 miles from here to-day, by the train breaking in two. Engineer Samuel Edgerly was killed almost instantly.

Davisville, R. I., May 10.—There was a rear-end freight collision at this point on the Stonington Division of the New York, New Haven & Hartford Railroad this morning. Engineer A. R. Wilson and Fireman W. B. Bogue sustained slight injuries from jumping. The headlight of the locomotive coming in the opposite direction dazzled the eyes of the engineer, so that they did not see the signals of the train into which they ran.

Menominee Junction, Wis., May 10.—A head-end collision occurred between a passenger train and a freight train on the Chicago & Northwestern Railroad to-day. The fireman had both legs cut off, and died soon afterward. The engineer was also killed.

Hammond, Ind., May 12.—The Monon passenger train from Louisville was wrecked 3 miles east of here this morning. Bridge workmen who left a switch open after passing with a hand-car are responsible. David Pope, the engineer, was injured.

Wilhite, Ala., May 18.—An engine was derailed by an open switch at this point to-day, and Engineer Whitman was killed.

Springfield, Mass., May 19.—The Adams express train from New York to Boston ran into an open switch below Elm Street on the New York, New Haven & Hartford Railroad just before 3 o'clock this morning, and crashed into a freight train back of the freight office. The express locomotive was damaged and freight cars were derailed. The engineer and fireman were slightly injured.

Princeton, Ky., May 19.—A collision occurred in Standing Rock tunnel on the Newport & Mississippi Valley Road to-day. The engineer and fireman jumped and escaped with slight injuries.

Effingham, Ill., May 20.—Passenger train No. 24 of the Illinois Central was wrecked to-day at Watson, 5 miles south of this city. Heavy timbers were wedged into the frogs of the switch at the south end, and a freight train had headed for the switch to let No. 24 pass. When the locomotive of the passenger train reached the obstruction it left the track and ran against the freight locomotive. Fireman Charles Walters of the freight engine was painfully injured, and George Baker of the passenger engine was also hurt.

Bordentown, N. J., May 22.—An extra coal train was wrecked at West Palmyra, on the Amboy Division of the Pennsylvania Railroad, this morning, by a washout. Engineer Fine was seriously injured.

Galesburg, Ill., May 25.—A lubricator glass in an engine on the Chicago, Burlington & Quincy Railroad broke at this point, and 3 qts. of kerosene were spilled through the cab. Fireman Ed. Martin was set on fire, and with flaming clothes rushed to the water tank and jumped in, extinguishing the flames. Engineer Giddings, after stopping his train, leaped from his engine and rolled around on the wet grass. The fireman's clothes with the exception of his undershirt were destroyed. He was horribly burned, and is in a precarious condition.

Aurora, Ill., May 24.—A fast train on the Chicago, Burlington & Quincy Railroad ran through an open switch near here last night. Fireman Ridgerley was fatally injured.

East Liverpool, O., May 24.—A collision occurred on the Cleveland, Akron & Columbus Railroad this morning between a freight and passenger train. Engineer James Johnston had his kneecap seriously injured, and Fireman Paisley sustained severe injuries. The other engineer and fireman escaped with slight injuries.

Philadelphia, Pa., May 24.—There was a collision between a Pennsylvania and Reading locomotive at Powelton Avenue this morning. The Reading engine was turned over, and Thomas Ryan, the fireman, was badly scalded about the head, neck, and arms. Thomas Roche, the engineer, jumped and escaped with slight injuries.

Aquilla, Tex., May 25.—An engine and six cars of a freight train on the Texas Central Railroad jumped the track here to-night. Engineer John Elliot was crushed beneath the *débris*.

Tyler, Tex., May 25.—While Engineer Frank Gurr with two assistants was testing a new locomotive on the Cotton Belt Line to-day, it jumped the rails and rolled down an embankment. All three men were fatally scalded.

North Yakima, Wash., May 27.—Back water from the Yakima River undermined a small bridge on the Northern Pacific Railroad 19 miles east of here this morning, and a freight train crashed through the bridge. Engineer Worth jumped, but was badly crushed.

Cumberland, Md., May 27.—An express train on the Baltimore & Ohio Railroad ran into a landslide 7 miles east of here this morning. Fireman Rhinehart was buried beneath the locomotive, as was also Engineer Nicholson. Both of them were killed and their bodies badly burned.

Salt Lake, Utah, May 29.—A work train on the Union Pacific collided with a passenger train near Castle Rock to-night, killing Engineer James.

Sharon, Mass., May 30.—As a berry train on the Old Colony Railroad was passing this point this morning, it crushed into some freight cars left on the north-bound track by the local freight train. The locomotive was somewhat damaged. The fireman, Edw. T. Goodwin, was scalded to death.

Milwaukee, Wis., May 30.—A through train for Chicago on the Wisconsin Central Railroad was wrecked early this morning at Mandville. A split switch had been tampered with, allowing the wheels of the locomotive to catch the point. James Hubbard, an engineer, and George Gearhart, fireman, were killed.

Our report for May, it will be seen, includes 24 accidents, in which 11 engineers and 6 firemen were killed, and 12 engineers and 10 firemen were injured. The causes of the accidents may be classified as follows:

Break in two	1
Bursting gauge-glass	1
Cattle on track	1
Collisions	8
Derailments	2
Landslide	1
Misplaced switches	6
Suicide	1
Train wrecking	1
Washouts	2
Total	24

SOME EXHIBITS AT THE CONVENTIONS.

THE Committee of Arrangements made the best preparations for the reception and display of exhibits that have yet been made. Mr. Clements, of Congress Hall, threw the back piazzas of his hotel open to all exhibitors free of charge provided they were guests of his house; if they were not, a small charge was made. An engine with boiler was provided, together with a line of shafting in motion from which power was taken for one or two devices. There was also a Westinghouse air pump providing air pressure for those who wished to avail themselves of it. Among those were sanding and ventilating devices and the Kinsman system of block signaling. Among the exhibits we selected the following as being especially worthy of mention:

L. O. Chase & Company made a more elaborate display at this convention than any previous one of the mohair car plushes

which they manufacture. These plushes are made at the Sandford Mills, of Sandford, Me. The especial features were the displaying of figured or frieze plushes, which are so generally used in parlor and sleeping car work, as well as the extra high plushes in all colors for the same purpose. The L. C. Chase Company's usual grade of low-pile plushes for the ordinary passenger coach work was shown in great variety of colors and in widths of 24 in. and 28 in. The framed specimens of the material which enters into the manufacture of plush attracted especial attention. This was arranged so that it showed the different stages through which the mohair passes from its crude state when taken from the Angora fleece to the completed state after spinning. There were also some fine specimens of crushed plushes. The exhibit was in charge of R. R. Bishop, Jr. It is worthy of notice that at the recent World's Fair at Chicago these plushes received five first medals and five diplomas, which was practically a sweepstake over other competitors.

The Consolidated Car Heating Company made an elaborate display of the several devices which they use in connection with their steam-heating appliances. The display of this company has always attracted a great deal of attention at previous conventions. They heretofore have had a working model of their apparatus, showing the various systems of direct circulation and commingler heating which are installed by them. They have, however, rendered this work so familiar that their models were wanting in this year's exhibit, but have been amply compensated for in the details which they have displayed. These details consisted of a large number of photographs and drawings of their work, together with samples of the new electric car heater which they are introducing, and which was thoroughly illustrated in our issue for June, 1893. This company has also recently made an arrangement for the introduction of the Pope compressed system of car lighting into this country. This system has been extensively introduced in England, and the exhibits consisted of a large number of special fittings with photographs of the application to cars with plans of the various compressing plants that are in use in England. Owing to the fact that the drawings and photographs were required at Saratoga until the last minute, we have been unable to reproduce them in this issue, but in our issue for August we expect to publish a complete description of the Pope system of lighting cars with compressed air.

Crosby Steam Gauge & Valve Company.—The display of this company, which has been for several years under the personal supervision of Mr. Edward C. Bates, always attracts a great deal of attention, not only on account of the arrangement, but of the beauty of the finish of the several instruments exhibited. This year they exhibited a vacuum test pump which is constructed with a mercury column, and is so arranged that it reaches a 28 in. vacuum with a very few strokes of the pump. Their gauge-testing machine with positive weights was also in evidence. This is a very simple device, and is one which the company has had upon the market for a number of years. Their steam-engine indicator had an attachment which is somewhat of a novelty, being Sargent's electrical attachment, so that any number of simultaneous cards may be taken at the same time by the closing of one indicator point. They also showed Johnstone's blow-off cock, which was designed by Mr. F. W. Johnstone, of the Mexican Central Railway, and which is kept closed by water pressure, and first blows out at the bottom and clears away all scale. It is operated with a direct pull, and seats itself. They also showed locomotive gauges with black face and white figures and white face with black figures, together with bromide enlargements of photographs of their supplies and of their World's Fair exhibit. In addition to these there were the water glass attachments and self-closing water glass cocks with a ball held in suspension by wires, which is pushed back by the valve, so that there is no danger of the closing ball becoming covered by scale and thus failing to close in case the water glass breaks. There were also muffled safety valves and plain Crosby valves, together with a syphon attachment for steam gauges. This latter is especially worthy of attention because it supplies an ample water leg below the gauge, and thus ensures water contact in the Bourdon spring at all times. Too much stress cannot be laid on the importance of proper syphoning of steam gauges, because when this is not done the direct heat from the steam will ruin the spring of the gauge in a short time. There was also a very neat design for a hot well thermometer.

The A. French Spring Company had samples of their half elliptic driving springs, and in connection with the Morris Box Lid Company showed the Morris box lid cover for oil boxes. Mr. Morris has also recently designed a steel cover for air brake hose which effectually covers the opening against any extraneous matter, and allows it to hang down or to be hooked up as with a dummy coupling if desired.

Kinsman Block System Company had a full-sized model exhibited of their apparatus, which was illustrated in the June issue of this paper. In connection therewith there was a short length of model track with trucks thereon, which could be run backward and forward, making the electric connections and applying the brakes. This exhibit attracted a great deal of attention on the part of all railroad men present; and the consensus of opinion was that it was not only decidedly novel, but very effective. For a full description of the apparatus we would refer our readers to our June issue.

The Ross Valve Company exhibited a rack with a full line of their reducing valves, together with blow-off valves. This exhibit was particularly attractive from the neatness and taste with which it was gotten up.

William C. Baker had a car heater on exhibition with the special appliances that are attached thereto, to which more particular reference is made in a special article in another column of this paper.

Simonds' Rolling Machine Company exhibited pins for brake connections and signals, staff bands, boiler patch bolts and track bolts. All of this material is rolled, and even the square heads attached to the boiler patch bolts, which are intended for breaking off, are rolled by their process.

Safety Car Heating & Lighting Company had their usual exhibit of Pintsch gas in operation. It consisted of a rack containing a tank of compressed gas with the regulating apparatus together with the cocks and lamps in operation. The light was very brilliant, and, inasmuch as it was located in a prominent position in the office of the hotel, attracted a great deal of attention.

Taylor Iron & Steel Company exhibited two of their manganese steel car wheels which had been subjected to a very severe drop test. These, we believe, were the same which were on exhibition at Lakewood one year ago, and which excited so much interest at that time.

Westinghouse Air Brake Company had a truck on exhibition showing the adaptation of their air brake to the front truck of a locomotive. This arrangement is clearly shown, together with the dimensions in our illustration which is presented herewith. It will be seen that there are two bars extending across the truck from side to side, bolted to the top frames, with trunnions at their outer extremities to which the brakes are hung. On the lower bar of the frame there are pivoted two floating levers, to the central portion of which the brake shoes of one pair of wheels are attached. As the brake piston moves outward these brake shoes are thrust up against the wheel while the compression connection on the outside leads back and forces the brake beam of the other two wheels and with it its brake shoes directly against the wheels. The construction is exceedingly simple, and will be readily understood from an examination of the engravings. They also showed an air brake inspection machine, which is also illustrated herewith. The figure represents a 10-in. passenger car cylinder with the machine attached ready to compress the release spring and bring the back head into position to be bolted to the cylinder. *A* is a rack-bar having an extensible portion, *B*. They are connected together with a right and left-threaded turnbuckle, *C*. Hardened steel center points are inserted in the cross-bars of *A* and *B*, making a rigid attachment to the cylinder by a slight pressure on the turnbuckle when adjusted to the cylinder as shown. *D* is a movable head having an adjustable centerpiece, *E*, for the cylinder head to rest on; this is raised or lowered to suit the size of the cylinder. A pinion gear, operating in the teeth of the rack-bar *A*, is connected to the movable head *D* by a shaft, and is operated by means of a crank or hand-wheel, *G*. As the head is moved toward the cylinder it is held in position by means of a pawl, which locks the pinion gear, and is operated by the spindle *H* and spring *F*, giving the workman the use of both hands to bolt the head to the cylinder. The machine is also capable of adjustment to the 14 in. car cylinder, and includes a packing former for each size.

Scarritt Furniture Company also exhibited photographs of the Forney car seat, and notice was generally given that they have opened an office at 32 Warren Street, where their car seats are in various designs of finish, and are now on exhibition.

The Morton Safety Heating Company exhibited a model of a car floor with an application of their heating system. Our readers will remember that this system of heating consists of a line of large pipes that are filled with a porous brick that absorbs the heat of the steam that is passed through it and stores it for future use in the heating of the cars.

RECENT EXPERIMENTS IN ARMOR.

MR. C. E. ELLIS recently read a paper on this subject before the Institution of Naval Architects, from which we make an abstract, referring more particularly to the use of the Harveyized plates.

"Speaking generally, the American trials are characterized by conditions rather more favorable to the plate than to the shot, while in France, with one or two exceptions, the reverse has been the case. In England, however, and in some of the trials made abroad, the authorities appear to have gauged most accurately the resisting power of the Harvey plate to the blow to be delivered, with the result that in many cases the shot and the plate appear to be equally matched. A good instance is to be found in the trials of Messrs. Cammell's and Messrs. Vickers' 6 in. steel plates on the *Nettle*. An examination of these trials will show that, with the highest velocity (1,960 ft. per second), a 6-in. Holtzer projectile was unable to perforate the plates, damaged as they had been by two previous rounds. According to the Gavre formula, this shot would have perforated 11 in. of wrought iron (or 13 in., according to De Marre's formula), so that we get a superiority to wrought iron of at least 183 per cent. Other instances may be found in the nickel steel 10½-in. plate of Messrs. Cammell and in the nickel-steel plate of the same thickness made by my own company, tested at Shoeburyness on November 9 and October 10, 1893, respectively. The Cammell plate was curved to molds supplied by the Admiralty, and was only penetrated to the depth of 10 in. In the Brown plate the projectile stuck in the plate, broken, and we may assume that each of the plates was a fair match for the blow delivered. The gun used was the 9.2, and, with a Holtzer shot of 380 lbs. and a velocity of 2,035 ft. per second (the highest obtainable), a striking energy was obtained of 10,900 foot tons. These conditions would give, according to the Gavre or De Marre's formula, a perforation in wrought iron of 22 in. or 22½ in., showing for the plates in question a superiority over wrought iron of 209.5 per cent. at least. Again, the Chatillon Commentry 6.7-in. plate gives an excellent example of a trial where the conditions of attack and defense approximate one another.

"Taking the severest blow, we find that the plate was not perforated by a shot which would, according to the Gavre formula, pierce a wrought-iron plate of 11.9 in., and, according to De Marre's, a plate of 13.8 in. in thickness; in other words, showing a superiority over wrought iron of 177 per cent according to the one, and of 205 per cent. according to the other formula.

"It was at first assumed that the Harvey process was considerably better adapted to nickel-steel plates than to all steel, and this is still, no doubt, the general opinion in the United States. In the Annapolis trials of 1890 the Schneider nickel-steel plate was undoubtedly superior to the all-steel plate made by the same firm; and in a trial of 3-in. plates in May, 1891, the nickel-steel Harveyized plate was stated to be better than the all-steel plate. In the Indian Head trials of the same year the low carbon all-steel Harveyized plate of the Bethlehem Company was placed considerably below the high carbon nickel-steel Harveyized plate of the same company; but in this case the consideration of the question was complicated by the difference in the carbons, as it is probable that a nickel steel plate would not require to be so high in carbon as an all-steel plate to give the same resistance. Since this trial, however, it seems to have been assumed in the United States that all Harveyized plates should be made of nickel steel. In Great Britain, however, the high cost of nickel has caused manufacturers to turn their attention to producing Harveyized steel plates containing no nickel, and an examination of the details of the various trials shows that all have succeeded in proving the reverse of the theory accepted in the United States. There may, perhaps, be a slightly greater tendency to crack in the all-steel than in the nickel-steel plates as tested in this country; but this is more than compensated for in the superior resistance to penetration. The 6 in. Portsmouth trials all demonstrate this fact; and attention may also be called to the trial on October 26, 1893, when experiment showed that the 10½-in. Brown all-steel plate more effectually broke up the 9 in. shot than was the case in the similar trial of the nickel-steel plate under the same conditions. The expense of the addition of nickel renders this question of such importance that I regret there are no foreign trials available for providing further demonstration, if such be needed.

"Apart from the question of extra cost, there are also practical considerations which affect the point in question. Some experiments made by Captain Tresidder show that a steel plate containing an ordinary percentage of nickel and a high percentage of carbon is practically unmachinable. If, therefore, a nickel-steel plate be taken containing, say, 3 per cent. of nickel, and it be supercarburized up to, say, 1 per cent., its face will be so hard (even before the chilling process is effected) that for all practical purposes it will be impossible to drill and tap the various small holes that are nearly always necessary to be made on the face of the armor plates for ships' sides. In the case of steel armor, this difficulty (which, I believe, has already arisen in the United States in the case of nickel-steel plates) does not exist, and thus one important objection to the adoption of the Harvey process for ships' plates as required by naval architects has been overcome by its application to all-steel armor in place of nickel steel.

"I must now allude to the doubts that have been expressed as to the difficulties which will be experienced by manufacturers in adapting the process to curved and twisted plates. Both the Dutch and the Austrian governments appear to have attached great importance to this consideration. No doubt there are, and will be, difficulties caused by the warping effect of the water treatment, and time alone will show whether they are as serious as the detractors of the system allege. I think, however—and I am sure I can speak for the other armor-plate manufacturers in this country—that any difficulties thus created will be readily overcome. In the first place, if a plate is uniformly heated and uniformly chilled any alteration of its form will also be uniform. A very little experience, therefore, will teach the operator the lines on which to work, particularly if the system of chilling in use is of a suitable character. We know also that the side armor for the *Maine*, made by the Bethlehem Company, has been accepted by the United States Government; and, although I have no accurate information on the point, we may safely assume that the plates were not straight. Both Messrs. Cammell and my own company have also successfully made sample Harveyized plates to molds having both curve and twist, and probably other manufacturers have done the same.

"It may be interesting to give an account of some mechanical tests showing the quality of the soft parts of Harveyized plates which have been successful in trials. In the early stages of our experiments a 4-ft. × 4-ft. × 9-in. plate was tested at Shoeburyness, breaking up the 6-in. Holtzer in the usual way without cracking. Test pieces were taken from the back of the plate with the following results:

	First Specimen.	Second Specimen.
Breaking strain per sq. in	31 tons.	30 tons.
Elongation per cent. in 2 in	31 "	31 "
Reduction of area per cent	57 "	61 "
Cold bends without fracture	180°	180°

The plate, it may be mentioned, was not of our special armor-plate quality. It gives, however, a sufficient indication that, apart from the face, the body of the steel does not, at least, suffer from the application of the process.

"One characteristic of this kind of plate must be specially mentioned. I refer to the extraordinary resistance given to shot by small fragments of plate only. Perhaps the most conspicuous instance of this is given by the Bethlehem 14-in. plate of February 11, 1893, where a 10-in. Holtzer projectile was fired, at a velocity of 2,059 ft. per second, at a piece of plate weighing only 4⅛ tons, and was broken up with a penetration of 11 in. The total striking energy of the blow was 14,715 foot-tons, or 3,344 foot-tons per ton of plate. Another example may be found in a recent trial of a 6-in. steel plate made by my company. The fourth shot of this trial was fired nearly at the center of the plate after cracks had been made, such that the point of impact was about the middle of an equilateral triangle, with each side measuring about 2 ft. The 6-in. shot, with a velocity of 1,815 ft. per second, was completely broken up; one small crack only was made, and the fragment of plate represented by the triangle, dished to the extent of an inch, showing the tough nature of the material. If, therefore, the Harvey plate be broken up, but its fragments still adhere to the backing, it still presents a considerable resisting power. It seems, however, from the foregoing remarks, that it might be desirable to have a greater number of bolts per square foot of plate than was the case in the old form of armor.

"With the above facts before us, we are enabled to form some idea of the improvements that have recently been effected in armor plate manufacture, and of the relative value of the various kinds of armor. Without disregarding the excellent qualities of the steel and nickel plates, I think that Harveyized

armor would be a more efficient defense to the vital parts of any ship of war, whether battleship or cruiser, than any other type of plate. Opinions may differ as to the percentage of superiority it possesses, but I do not think I am overestimating its value when I place its resisting power at 50 per cent. above the steel and compound plates of 1888, which I have chosen as the basis of comparison. This advantage can be used by the naval architect in one of two ways: he can either clothe with armor a greater part of his ship, or he can obtain greater resistance, keeping the same thickness of armor. The new development is, therefore, of the greatest importance; and it will be a matter of satisfaction to this Institution that the British Admiralty have been the first naval authority in Europe to realize the value of this new form of armor, and to apply it to their most recent designs."

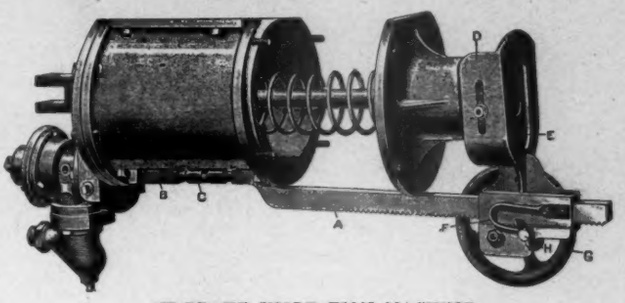
OBITUARY.

ROBERT E. RICKER.—The death of Robert E. Ricker was announced from Weeping Water, Neb., on May 18. Mr. Ricker was formerly Superintendent of the Vandalia Line, Superintendent of Motive Power of the Pennsylvania Railroad, General Superintendent and Engineer of the Central Railroad of New Jersey, and Superintendent of the Manhattan Elevated Railway, in New York.

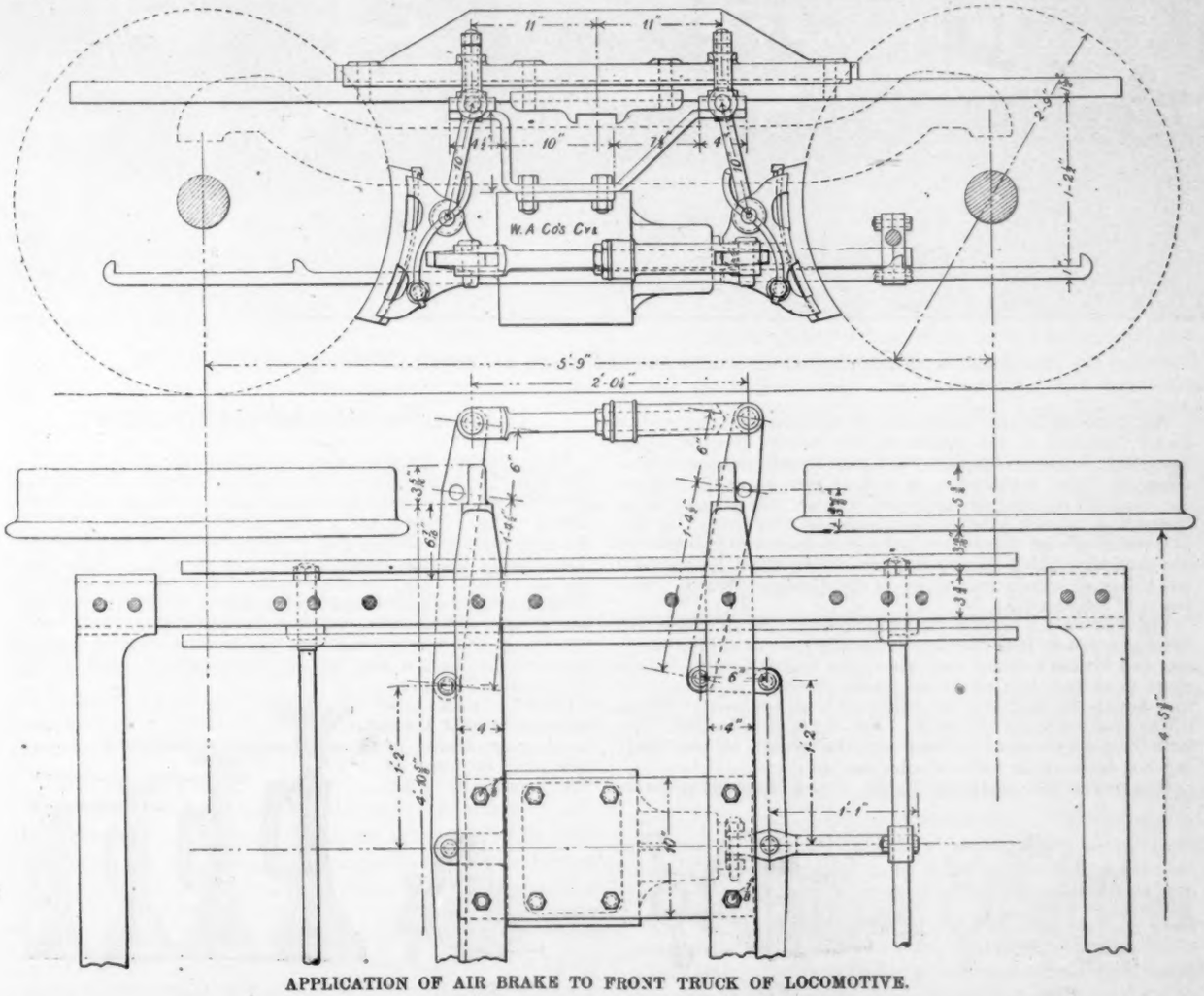
General Notes.

Poor's Manual will hereafter be published from No. 44 Broad Street, New York.

The Bloomsburg Car Company report that, notwithstanding the dull times, they are working nearly their full force, and are just finishing a large order of freight cars for the New York, Susquehanna & Western Railroad, 50 of which are to be equipped with the beamless brake. Many features of the brake have been improved over that shown at the World's Fair. With the beamless brake, as now constructed, the stopping qualities are greatly enhanced. The company also have a large order for mining cars which are to be equipped with the manganese steel wheel made by the Taylor Iron & Steel Company, of High Bridge, N. J. The capacity of the works is now rated at six freight cars a day.



AIR-BRAKE INSPECTION MACHINE.



APPLICATION OF AIR BRAKE TO FRONT TRUCK OF LOCOMOTIVE.

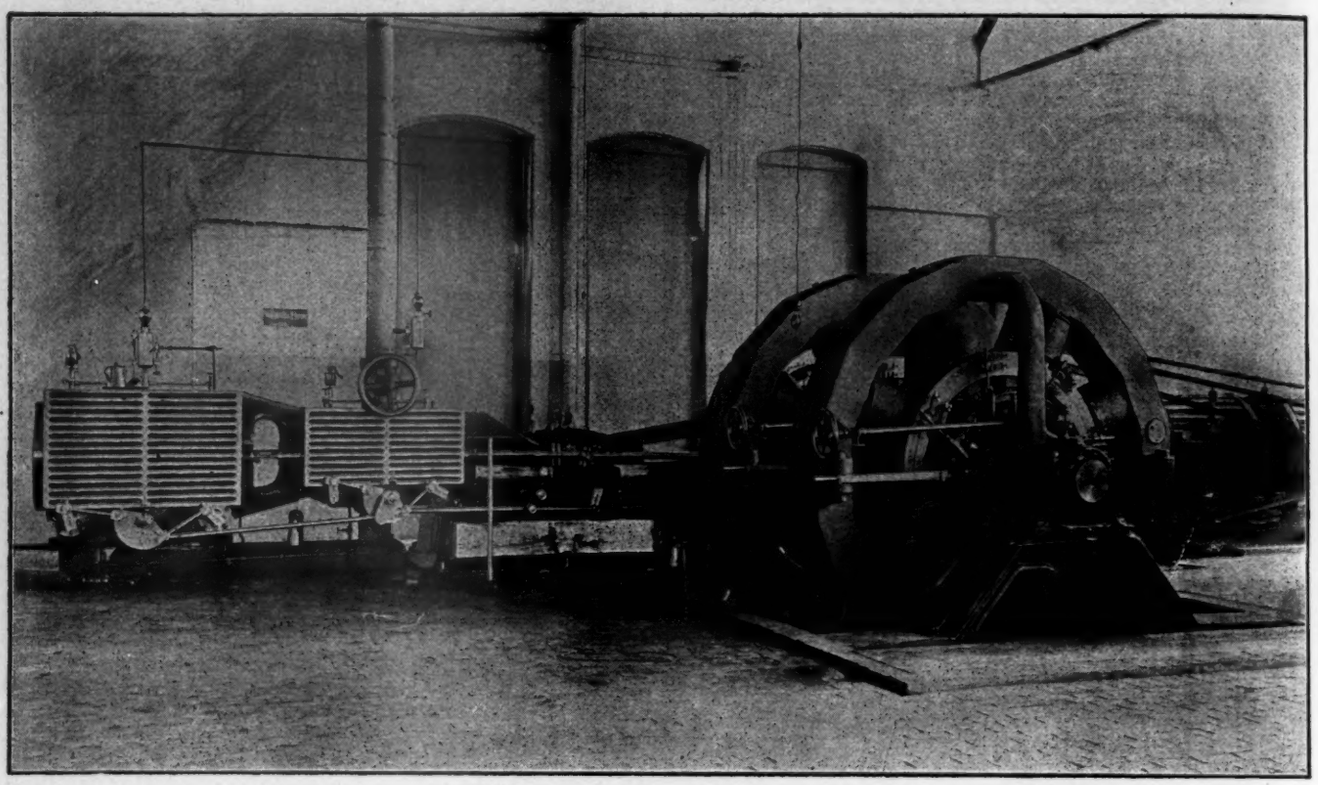
Manufactures.

DIRECT CONNECTION ENGINE AND DYNAMO.

THERE has been a constant tendency during recent years in the equipment of electric power and lighting plants toward the direct coupling of the engine to the dynamo shaft. The two methods in use are to use a slow-running dynamo or a

high-speed engine, both of which have given more economical results than those obtained by the intervention of belting.

vacuum of 25.75 in., the engine making the same number of revolutions, the indicated H.P. shows it 327.75 with a water consumption per indicated H P. of 15 59 lbs.



DIRECT CONNECTION ENGINE AND DYNAMO, MADE BY RUSSELL & CO., MASSILLON, O.

We illustrate in this connection a new plant which was recently installed in the station of the Edison Electric Light Company, of Grand Rapids, Mich., by Russell & Co., of Massillon, O. The installation, as will be seen from the engraving, is direct coupled dynamos and engines, and presents some features of interest which deserve especial attention. The out fit consists of one four-valve compound condensing engine 15 in. × 24 in. × 24 in., rated at from 300 to 400 H.P., and two one-killowatt generators made by the General Electric Company, of Schenectady, N. Y.

The bed of the engine and the fields of the dynamos rest upon a common iron base, the main shaft of the engine carrying, in addition to the flying wheel, the two armatures. This shaft is carried by two pillow blocks mounted in detachable iron stands so that the armatures may be removed without lifting the shaft out of place. The engine is a tandem type with the high-pressure cylinder next the cross-head, and stuffing-box between the two cylinder heads.

In a recent test conducted by Mr. Frank Simonds to determine the engine's economy in verification of the builders' guarantees, the following results were obtained :

In a six-hour trial, while running non-condensing, with an average steam pressure of 139.5 lbs., the engines making 162 revolutions per minute, the average indicated H.P. developed was 307.74 and the water consumed per indicated H.P. was 18.35 lbs. Another trial of the same length with an engine running condensing, the steam pressure being 130 lbs. with a

CAPITAL VISES AND JACK SCREWS.

THE Capital Machine Tool Company, of Auburn, N. Y., are manufacturing a line of vises and jack screws, illustrations of which we give in the accompanying engravings, figs. 1, 2, 3 and 4. Fig. 1 represents a wood-work vise which opens 10 in. with one movement. Fig. 2 is the sectional 7-in. plumber's vise, taking in pipe ranging from ¼ in. to 5 in. with one simple movement. Fig. 3 is a machinist's vise ready for use, with which the user stands in the same position as with the common screw vise. The vise is closed with one sliding motion with one hand and without turning the screw until the work is reached, and then a half turn of the handle or screw secures the work. The principal advantage claimed is that there is the great saving of time and no turn of the handles to bring the jaws to the work, simply a sliding movement, so that the wear on the screw and nut is very much less than in the old method. In this way it is naturally seen that the screw and nut are used very much less than in the old way and with a corresponding less amount of wear. The advantages claimed by their jack screws are that they are full size screws, that the collars are of steel, and screws of the same material. A diploma and medal was awarded the firm at the Chicago Fair.

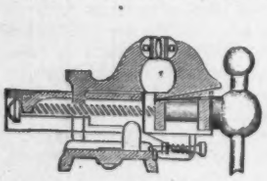


Fig. 1.

Fig. 2.

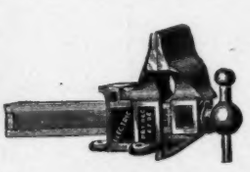


Fig. 3.

Fig. 4.

THE CAPITAL VISES AND JACK SCREWS.